THE UNIVERSITY OF THE WEST INDIES
AT ST. AUGUSTINE, TRINIDAD AND TOBAGO

A Research Paper

Submitted in partial requirements

for HUEC 3012

of

The University of the West Indies

Title: Fermentation of bilimbi (*Averrhoa bilimbi L.*) wines: Physicochemical and Sensory characteristics.

Student Name: Fayola O. Berkley

Project Supervisor: Neela Badrie

Year Submitted: 2010

Department of Agricultural Economics & Extension
Faulty of Food and Agricultural

Fermentation of bilimbi *(Averrhoa bilimbi L.)* wines: Physicochemical and Sensory characteristics.

A Research Paper

Submitted in Partial requirements for HUEC 3012

of

The University of the West Indies

Fayola O. Berkley - 807001882

Supervised by

Dr. Neela Badrie

2010

Acknowledgement

Some key persons must be acknowledged for the work completed on this project. Firstly, Mr. Meghnath Gosein, who provided the fruits, Mr. Esau Mohammed, Mrs. Vidya Bridgebassie of the Microbiology laboratory and Mr. Keshwar John of the Food microbiology laboratory for technical assistance. In addition, Dr. Neela Badrie for supervising the project.

Table of Contents

List of Tables and Figures

TABLES

FIGURES

PLATES

Abstract

Background The fruit of *Averrhoa bilimbi* L., or bilimbi, is considered an underutilized fruit of the Oxalidaceae family. The bilimbi is not usually consumed raw due to its high acidity and processing of bilimbi could increase utilization of this fruit, reduce wastage, improve on the economic returns of farmers and increase the value of the crop. This study focuses on bilimbi wine quality in relation to osmotic dehydration treatments applied before the fermentation of the must.

Materials and methods. Mature bilimbi were pre treated in four different osmotic dehydration sucrose solutions (control-no sucrose solution, 30°, 50° and 65° Brix). Prior to fermentation, musts adjusted to 25 °Brix and pH 3.0–3.5. Wines were racked, bottled and assessed using physicochemical analysis and sensory evaluations. A focus group session chose the better two wine treatments out of the four produced. A sensory quality evaluation panel attributed scores to the selected wine treatments.

Results and discussion. Osmotic dehydration significantly affected the pH levels which played a role in terms of color and flavor the wine treatments .The sample with the lowest pH produced the sweetest wine while the sample with the highest pH had the most favorable color by consensus. There were no significant ($P>0.05$) physicochemical differences between samples during fermentation but there were significant ($P<0.00$) sensory differences between the features of the selected wines. All the wine treatments were microbiologically stable. The alcohol content ranged between 12%-15% and 7°-9° Brix.

Conclusion: Osmotically dehydrating the fruits prior to fermentation produced well accepted wines. Both wines were judged as standard and the sweeter wine preferred.

Introduction

The bilimbi is not a commonly used fruit in Trinidad and Tobago but is sometimes added in the production of chutneys and pepper sauce. There are no known differences between the types of bilimbi, all being very sour and there are no named varieties (Andrews & Ragoonath, 1990).

Despite the fact that the fresh fruit is extremely acid to taste (Morton, 1987; to be eaten unprocessed (Andrew & Ragoonath, 1990) it was decided that research should be done to determine if Wine could be a possible additional method for processing the fruit. The fruit must be utilized within 24 hours after harvesting because of a short shelf life. (Andrew & Ragoonath, 1990) This would add value to the product and according to the acceptance, could possibly be commercialized. Bilimbi wine could possibly reduce the amount of wastage which occurs with the fruit and provide additional income for farmers.

The Bilimbi is quite similar to the carambola as they both belong to the *Averrhoa* family (Morton, 1987). The wine procedure used a modified format used in the Production of the carambola wine (Bridgebassie & Badrie, 2004).

It is quite customary for citizens to engage in Wine making from local fruits however, most of it is not documented. This research project will outline the procedure, physicochemical changes and acceptance of the Bilimbi Wine and add to the body of knowledge available and possibly probe for further work to be done on the fruit.

Objectives:

The main objectives of the study were to investigate the effects of pretreatments on the bilimbi fruit (*Averrhoa bilimbi* L.) by varying the application of sucrose concentration used in the Osmotic dehydration process and its possible effect on physicochemical parameters and sensory quality of the wines.

Specific Objectives:

The objectives were to:

(1) determine the physicochemical changes from the fresh fruit, primary fermentation, first and second racking of the wine.

(2) acquire opinions of consumers of the wine treatments which were osmotically dehydrated in varying degrees of sucrose solutions and to select the best two out of the four wine treatments by focus group evaluation.

(3) determine the sensory quality of the two preferred wine treatments.

Hypothesis: to determine if the differences in the Osmotic dehydration treatments had an effect on the sensory and physicochemical characteristics among the wines.

Plate 1- The bilimbi fruit clusters

Plate 2- Close up view of bilimbi fruits

Plate 3- bilimbi fruit clusters on the tree

Plate 4- Pictures of multiple bilimbi clusters

Literature Review

Averrhoa Bilimbi L.

Various Names

The bilimbi (*Averrhoa bilimbi*) is a member of the Oxalidaceae family (Andrews and Ragoonath, 1989). It is closely allied to the carambola but quite different in appearance, manner of fruiting flavor and uses (Morton 1987).

The bilimbi is known locally as "khamrak" or "kornishore" and in other countries known as by the English (cucumber tree, bilimbi, tree sorrel); Filipino (kamias); Indonesian (belimbing asam,belimbing wuluh); Khmer (tralong tong); Malay (belimbing buloh, belimbing asam,b'ling,billing-billing); Spanish (tiriguro,pepino de Indias, mimbro,grosella china,vinagrillo); Thai (kaling pring,taling pling). (Morton, 1987).

Characteristics of bilimbi fruits

Ripe bilimbi fruits have thin skin, yellowish-green color, soft texture and a peculiar smell, which resembles the one of carambola, a fruit of the same botanical family. Half-ripe fruits have firm texture and imperceptible smell. (Morton, 1987). Bilimbi is a small tree up to 15 meters high. Fruits are fairly cylindrical with five broad rounded longitudinal lobes, and produced in clusters (Figure 1and 2). (Mathew et al, 1993).

The Bilimbi is somewhat cylindrical with five broad, rounded, longitudinal lobes (Andrews & Ragoonath, 1989). Fruit is faintly 5-sided, approximately 4-10 cm long; capped by a thin, star-shaped calyx at the stem-end and tipped with 5 hairlike floral remnants at the apex. During the maturity stage, the maximum increase in fruit weight and dimensions occurs, and their external green color changes into light yellow (Mathew et al., 1993).

The fruit then turns to ivory or nearly white when ripe and falls to the ground. The outer skin is glossy, very thin, soft and tender, and the flesh green, jelly-like and extremely acid. (Morton, 1987). This fruit is juicy and yields 76.14% in juice . (Mathew et al., 1993). There may be a few (6-7) flattened, disc-like seeds approximately 6 mm wide, smooth and brown. Generally, the tree begins to flower around February and then blooms and fruits more or less continuously until December. (Morton, 1987).

In 1973, the bilimbi was brought from Timor to Jamaica and then a few years after, was planted in Trinidad and Tobago. It was indicated that bilimbi are mostly the same wherever they are grown but it is reported that there may be a sweet variety discovered in the Philippines (Morton, 1987).

Value-added Products from bilimbi

The Bilimbi fruits are very sour, and used in the production of vinegar, wine, pickles and in the preparation of Hindu dishes. (Mathew et al., 1993). The bilimbi is generally regarded as too acidic for eating raw, but in Costa Rica, the green, uncooked fruits are prepared as a relish which is served with rice and beans or an accompaniment for fish and meat. Ripe fruits are frequently added to curries in the Far East (Morton, 1987).

The juice of the fruit has a pH of 4.47, is popular for making cooling beverages. Mainly, the bilimbi is used in place of mango to make chutney, and it is usually preserved (Morton, 1987) or processed into jams and jellies.

Medicinal Uses

Medicinal uses are attributed to bilimbi, which include mixtures against cough, mumps, rheumatism, pimples and scurvy. Throughout the world, many traditional plant treatments for diabetes exist and therein lies a hidden wealth of potentially useful natural products for the control of diabetes (Gray and Flatt, 1997).

It is used as antibacterial, antiscorbutic, astringent; post–partum protective medicine; treatment of fever, mumps, pimples, inflammation of the rectum and diabetes (decoction of the leaves); treatment of itches, boils, rheumatism, cough and syphilis (paste of leaves); treatment of scurvy, bilious colic, whooping cough, hypertension and as a cooling drink (juice of preserved fruits); treatment of children's cough (syrup of flowers); treatment of stomach ache (fruits). (Goh et al., 1995).

Averrhoa bilimbi L. (Oxalidaceae, common name: Bilimbi), has been widely used in traditional medicine as a cure for cough, cold, itches, boils, rheumatism, syphilis, diabetes, whooping cough, and hypertension . (Goh et al., 1995). In the Philippines, the leaves are applied as a paste or applied on itches, swellings of mumps and rheumatism, and on skin eruptions. Elsewhere, they are applied on bites of poisonous creatures.

Malaysians take the leaves fresh or fermented as a treatment for venereal disease. A leaf infusion is a remedy for coughs and is taken after childbirth as a tonic. A leaf decoction is taken to relieve rectal inflammation.

A flower infusion is said to be effective against coughs and thrush. In Java, the fruits combined with pepper are eaten to cause sweating when people are feeling "under the weather". A paste of pickled bilimbis is smeared all over the body to hasten recovery after a fever.

The fruit conserve is administered as a treatment for coughs, beri-beri and biliousness. Syrup prepared from the fruit is taken as a cure for fever and inflammation and to stop rectal bleeding and alleviate internal hemorrhoids.

In addition, *A. bilimbi* has been widely reported for its multiple ethnopharmacological properties such as anti-inflammatory, anti-scorbutic, astringent, anti-bacterial, and postpartum protective properties (Goh et al., 1995).

In Indonesia it has a considerable medicinal reputation as a potent folk remedy in the treatment of diabetes mellitus (Wee Yeow Chin, 1992) . Epidemiological studies have shown that there is a positive association between intake of vegetables and fruits and reduced cardiovascular diseases (Hu, 2003) and certain cancers (Riboli and Norat, 2003). It is generally assumed that the main dietary constituents contributing to these protective effects are the antioxidant components (Agudo et al., 2007).

Along with other antioxidant components, polyphenols (e.g. flavonoids) present in fruits and vegetables have been reported to be potential candidates in lowering cardiovascular diseases (Huxley and Neil, 2003; Joshipura et al., 2001). The protective effects could be due `to their properties as free radical scavengers, hydrogen-donating compounds, singlet oxygen quenchers and/or metal ion chelators.

Underutilized fruits like the *Averrhoa bilimbi* have not received much attention as antioxidant sources compared to commercial fruits like guava, papaya and pineapple. This could be due to their lack of popularity among local communities, lack of information on nutritional compositions and physical qualities and the lack of promotional campaigns for these fruits (Ikram, et al, 2009).

However, the *Averrhoa bilimbi* has been found to contain moderate phenolic content (1261.63 _ 31.41) per 100 g edible portion) and antioxidant activity 91.89% based on b-carotene bleaching assay (Ikram, et al, 2009).

Oxalic acid has been identified as the main acid in carambola and in bilimbi (Joseph & Mendonca, 1989). The oxalic acid levels in bilimbi ranged between 8.57 and 10.32 mg/g. These high levels of oxalic acid found in bilimbi are probably responsible for its extremely low pH value (0.9-1.5 in both maturity stages).

Ripe bilimbi fruits have higher Vitamin C content than half ripe ones. The levels of vitamin C in ripe and half ripe bilimbi fruits varied from 20.82 to 60.95 mg/100g (Lima et al., 2001) .This result may have been influenced by climatic factors. As expected, during the dry season, an increase of photosynthetic activity produces higher levels of vitamin C, since this vitamin is synthesized from hexose sugar precursors (Harris, 1977).

Therefore, the medicinal use of this fruit against scurvy, which was recommended by Corrêa (1926) and Wong & Wong (1995), can be justified.

Osmotic dehydration

Due to the extremely acidic nature of the bilimbi, it was suggested that the fruits be soaked overnight to reduce the acidity. The concentration of food products by means of product immersion in a hypertonic solution (i.e. sugars, salt, sorbitol or glycerol) is known as osmotic dehydration. (OD) (Raoult-Wack et al., 1989; 1991). Also the term OD has been coined as 'dewatering and impregnation (DI) soaking process' (Raoult-Wack et al., 1992).

This effective process involves two major simultaneous counter-current flows across a semipermeable cell membrane; solute flows from the osmotic medium into the product and water flows out of the food into the osmotic medium (Lenart. & Flink, J.M. 1984; Lenart, A. 1992; Talens et al., 2002) which results in an increase of the water activity of the osmotic medium. (Torreggiani, D. 1993; Salvatori, D. & Alzamora, S.M. 2000). Osmotic dehydration is a gentle process which results in a product with better color, texture and flavor (Yang and Le Maguer, 1992).

Focus Group

A focus group session was conducted during this research project. A focus group is a special type of group in terms purpose, size, composition and procedures. The purpose of conducting a focus group is to listen and gather information. Focus groups are carefully planned series of discussion designed to obtain perceptions in a defined area of interest in a permissive, non-threatening environment. Each group is conducted with 5 to 10 people led by an interviewer. The discussions are relaxed and participants enjoy sharing their ideas and opinions (Krueger & Casey, 2000).

Sensory Evaluation

After the focus group session, sensory quality evaluation measures were completed. Human perception of foods and consumer products are the results from complex sensory and interpretation processes. These processes are completed by the central nervous system which are difficult or impossible to predict from instrumental measures.

In many cases, many instruments lack the sensitivity of human sensory systems for instance smell. Instrumental assessment gives values that miss an important perceptual process: the interpretation of sensory experience by the human brain prior to responding. Only human sensory data provide the best models for how consumers are likely to react to food products in real life. (Lawless & Heymann, 1998)

The basic approach to modern sensory analysis is to treat panelists as measuring instruments. Sensory testing can establish the worth of a commodity or even its very acceptability and provides data on which sound decisions can be made (Meilgaard, 1999).

For wine analysis, a nucleus of 15 to 20 trained testers is usually adequate. Individual tasters perceive tastes and odors differently and probably assess wine differently. A sufficient amount of tasters should be sufficient to buffer these idiosyncrasies or the tasters must be trained for consistent assessment of the sensory attributes required. (Jackson, 2000). The timing of an evaluation session is important. Most people are at their best just prior to mid day or evening meal. (Jackisch,1985)

Wines are often grouped by alcohol content. This is indicated in terms of table wines- alcohol contents ranging between 9-14% by volume and fortified – alcohol contents ranging between 17 to 22%. Popular dry white wines possess a clean refreshing mouth feel and fruity bouquet, balanced with lively acidity.

Most white wines are dry as befits their primary use as a food beverage. The fresh, crisp acidity achieves balance in combination with food, enhancing food flavor reducing the fish character of some sea- foods.

Sweet wines are used as dessert wines and dry wines are used for appetizers. Dessert wines as marketed generally range from 6 to 8 degrees Brix (Amerine & Singleton, 1968).

The main requirements for any wine are sufficient alcohol to help preserve it and give it a wine like character, enough acidity to provide essential wine tartness and prevent spoilage, Nutrients for proper yeast growth and Pleasing fragrance and flavor components (Jackisch, 1985).

The Bilimbi fruit was used in this project to ferment into wine and its physiochemical characteristics, suitability as a wine and the acceptability of the final product was determined and assessed.

The hypothesis to be tested is to determine if the differences in the Osmotic dehydration treatments had an effect on the sensory and physicochemical characteristics among the wines.

Methodology

Materials and methods

2.1 The Bilimbi Fruit

Mature bilimbi fruits (*Averrhoa bilimbi* L.) were used of no known variety were obtained from Mr. Meghnath Gosein after harvesting from his trees at the University of the West Indies Field station, Mt. Hope, Trinidad, West Indies. The mature fruits were harvested and kept sturdy during transport to prevent damage and moisture loss. The bilimbi fruits have a very short shelf life (Andrews & Ragoonath, 1989) and were refrigerated until the next morning at 5-7 ° C at the Microbiology Laboratory.

Table 1- Physicochemical characteristics of fresh fruit

Parameter	Mean
TTA	0.75 (0.01)
TSS	3.83 (0.16)
pH	2.08 (0.09)
L	42.25 (2.34)
C	21.11 (2.28)
H	110.77 (3.03)
Length	63.14mm (3.87)
Width	25.047mm (0.91)

* Length and Width measurements of Fresh fruits were taken with an Electronic Digital caliper (Model 62379-531, VWR, Control Company, Friendswood, TX. USA).

2.2 Osmotic Dehydration:

For the production of the Bilimbi wine (Figure 1), the washed fruits were divided into four stacks with equal weights 1300g. The Osmotic agent sucrose was dissolved in 1.5 L of water for each treatment to the required Brix degree.

The treatments were as follows:

Treatment	Description
T0	Only water control – no Osmotic sucrose solution
T30	30° Brix
T50	50 ° Brix
T65	65 ° Brix

The fruits were left to soak for 24 hours in the respective °Brix solutions at 20-22 °C to reduce the acidity of the fruit before fermentation.

2.3 Fermentation

Figure 1 shows the processing steps for the fermentation of the Bilimbi wine. After the fruits were removed from the buckets following the Osmotic dehydration process, they were diced and blended (Oster, model #

889 16R, New Harford, Connecticut, USA) into a pulp using speed number 3 for 3 minutes. Water (1 L) was then added to the blended fruit and then pasteurized at 85 °C for 10 minutes.

The must was prepared by with the addition of pectolase enzyme (Young's Home Brew Ltd., Bilson, West Midlands WV 14BDL) and citric acid added in the amounts of 0.25% and 1% respectively per weight of fruit in each treatment. The blended fruits were then left to incubate for 24 hours at 20-22 ° C prior to the addition of yeast.

Water (3L) was added to each must treatment. Granulated sucrose was added to adjust the total soluble solids of the must to 25° Brix and the pH was adjusted from an initial average of 2.30 to the range 3.0- 3.5 with Sodium Hydroxide (NaOH).

Wine yeast (Saccharomyces *cerevisiae*, Young's brew Wine yeast Super compound, Bilson, West Midlands WV 14BDL) and yeast nutrients (5 g 4L; a mixture of diammonium phosphate and ammonium phosphate; Young's Brew Yeast Nutrient, Bilson, West Midlands WV 14BDL) were added to each treatment.

The musts were left in buckets to facilitate primary fermentation at 23 °C for 7 days. The wine was then siphoned in to sterilized demijohns to which air locks were fitted. A secondary fermentation as carried out for 3 weeks at 20- 22 °C.

After secondary fermentation, 100g sodium metabisulphite . m^{L-1} was added to the demijohns and the 0.1 % bentonite (Taste Maker Manufacturing Company Ltd, Port of Spain, Trinidad) was added to clarify the wine.

Wines were racked and then bottled in 750ml clear bottles and stored at 23°C.

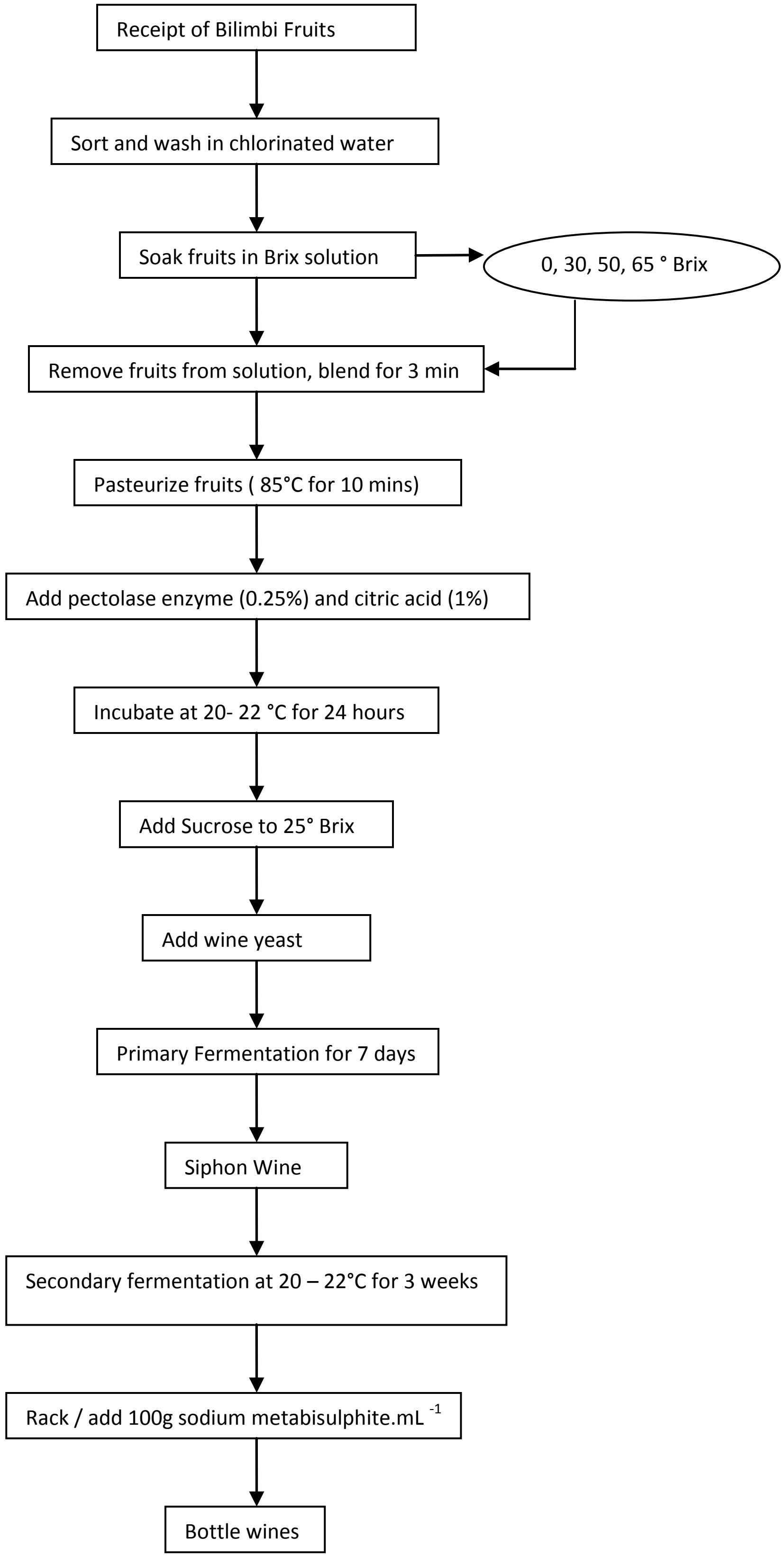

Figure 1- Steps in fermentation of bilimbi wine.

2.4 Experimental design

The experimental design comprised of four wine treatments which were prepared to correspond with the concentration of sucrose solution medium (0, 30°, 50° and 65° Brix) used to facilitate the Osmotic Dehydration process.

Periodic tests were done on each sample to gather information on the physicochemical characteristics (color, TSS as °Brix degrees), pH, Total Titratable acidity, alcohol and sensory quality (appearance and color, aroma and bouquet, taste and flavor, balance, duration and finish and Total Quality) and for microbial counts (total aerobic plate counts, yeasts and moulds and lactobacilli.)

2.5 Statistical analysis.

The data from the physicochemical analyses and sensory quality evaluation were subjected to analysis of variance using Minitab Statistical Software 15 for Windows (Software version 15, (Minitab Inc, State College, PA, USA). The changes in wine samples after osmotic dehydration and during the fermentation stage were investigated. Differences in the scores for the wine samples in addition to wine features were also assessed using the General Linear Model Minitab at a $P < 0.05$ significance level.

2.6 Physicochemical analysis

Color

The color of the fresh bilimbi fruits and wines were measured using the Minolta Chroma meter (Model # CR – 200 b, Minolta Co. Ltd, Osaka, Japan. Before each measurement, the colorimeter was calibrated with a white tile where the readings were L 92.6, a 0.3137, b 0.3209) and the tristimulus values of L, a, b were recorded.

L represented the lightness and darkness of colors, negative '*a'* was green, positive '*a*' was red, positive '*b'* was yellow and negative '*b'* was blue. (Francis, 1998).

Hue which is also called Munsell H and Chroma (Munsell C) were calculated from the 'a' and 'b' values according to (Francis, 1998). Hue denotes the shade or tint (Jackson, 2000) while Chroma refers to the intensity of the color (Francis, 1998).

pH

The pH of the bilimbi fruits were measured electronically with the aid of electrodes of the Orion pH meter (Model 520A, Orion Research Inc., Beverly, MA, USA).

Total Soluble Solids

Total soluble solids (TSS) as °Brix was determined on the fresh bilimbi fruit, must and wines using a refractometer (Leica Model, Atago E Type Series, Leica Inc., Buffalo, NY) (Bradley, 1998)

TTA

Total Titratable acidity (TTA) was expressed as % citric acid after titration of 10mL of sample with 0.1 N NaOH and phenolphthalein indicator as outlined by # 962.12 (AOAC 1990).

Alcohol

The percentage (v/v) of alcohol in wines was measured by the specific gravity alcohol content was determined by the specific gravity as outlined by # 920.57 (AOAC, 1980).

2.7 Microbial analyses

Total plate count, yeast and molds, and lactic acid bacteria were enumerated using serial dilutions of the wines followed by the pour plate technique. Plate Count Agar (PCA, Difco, Detroit, MI), Tomato Juice Agar (TJA, Difco, Detroit MI) and Potato Dextrose Agar (PDA, Difco, Detroit, MI) were used in the enumeration of total aerobic mesophiles, lactic acid bacteria and yeast and molds. PCA plates were incubated at 35 °C.

2.8 Focus group

A focus group session was conducted in an odor-free room which was lit by fluorescent lighting at the Food Microbiology Laboratory, University of the West Indies, St. Augustine, Trinidad, West Indies. Initial assessor selection criteria were based on personal interest and availability, over the age of 18 and willingness to undergo an open discussion on the wines.

Ten untrained panelists who are consumers of fruit wines were selected for the focus group session to discuss the wines (Krueger & Casey, 2000). Each member was asked to comment on the different aspects of the wine. This was done to gather quantitative information and assist in making a decision of the two better wine treatments.

A brief questionnaire (see appendix) and a form for recording options and thoughts were provided to each panelist. Deionised water and Crix ® biscuits (Bermudez Biscuit Company Ltd, Mount Lambert, and Trinidad) were presented to each panelist to cleanse palate between samples (Jackson, 2000).

The order of presentation of wines to the panelists was randomized. All samples (30 ml) were coded and served chilled (18–20 °C). The temperature of the wines was important as the taste of tannins is less obvious at a low temperature (Meilgaard, 1991).

2.9 Sensory quality evaluation

Sensory evaluation was conducted at the sensory evaluation room of the Food Biology laboratory, University of the West Indies. For sensory quality testing, each of the 16 panelists (8 males, 8 females) between the ages of 22–55 years was presented with a questionnaire (See Appendix) and the coded wines. The panelists were students of the University of the West Indies, Trinidad.

Two wine treatments were served in a random order to each panelist to avoid presentation errors. The panelists were presented with Crix biscuits, Bermudez Biscuit Company Ltd, Mount Lambert, Trinidad and deionised water for rinsing between wine samples.

The wine treatments were chilled at 7 °C for 24 h prior to serving and approximately 30 mL of each of The wine treatments were served to the panelists in three-digit coded transparent cups. Sensory panelists were selected for their interests, drank other types of wines, had participated in other sensory evaluation and were willing to undergo training.

In training, the objectives of the study were indicated, the wine vocabulary descriptors were explained and panelists were familiarized with the bilimbi wines and in the scoring of wines. Each panelist was then asked to evaluate the bilimbi wines for the quality attributes.

Wines were rated on a 34 point scale (a modified version of the 20-point rating system for wine quality) based on appearance and color (1–5 score), aroma and bouquet (1–7 score), acidity (1-3 score), balance (1–3 score), body (1-3 score), flavor (1-5 score), finish (1-3 score) and overall quality (1-5 score) as described by Jackson (2002).

The wines were judged as superior 27-34, standard 19-26, below standard 12–19 and unacceptable 1–12 out of 34 point overall sensory quality score.

Results and Discussion

Quality

All the bilimbi wine samples had less than 10 cfu·mL–1 of total aerobes, yeast and molds and lactic acid bacteria, and thus were microbiologically stable.

Alcohol

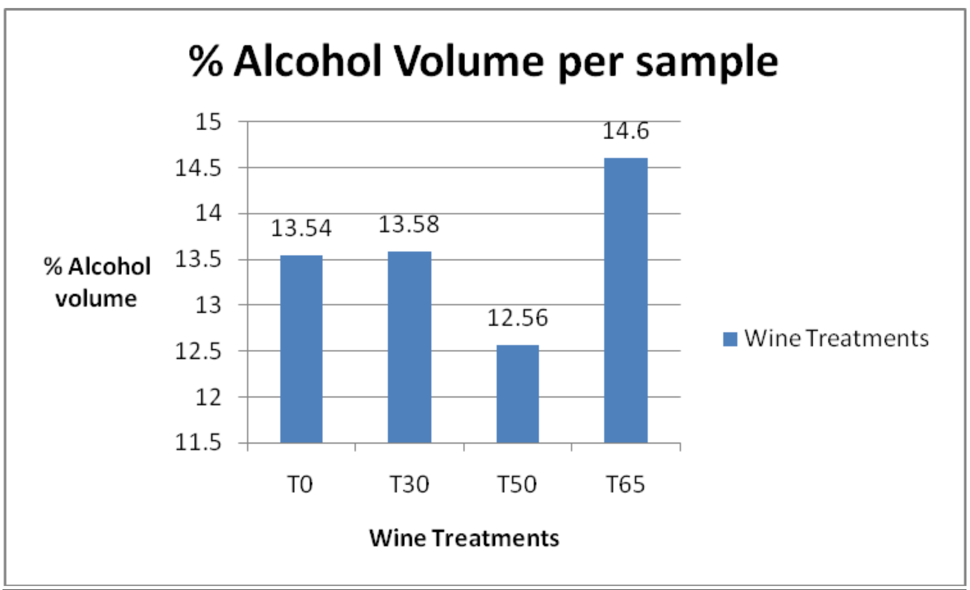

Fig 3- % Volume alcohol levels between Treatments

Fig 3 shows the % Alcohol content of the wine samples. The sample soaked in 50° Brix solution had the lowest alcohol content. This sample also had the highest level ° Brix and was noted to be the sweetest of the wine samples. The sample soaked in 65° Brix had the highest alcohol content.

Focus Group Sensory Evaluation

The primary interest in conducting a focus group session is to generate the widest possible range of ideas and reaction more than attempting to get definite information on any specific points (Resureccion, 1998).Qualitative research should preceed quantitative testing which would serve as an aid in the explanation of quantitaive data. (Chambers & Smith, 1991).

Treatment 0 – (No osmotic sucrose solution) - Panelists commented on the high fruity scent, acceptable alcohol level, had a dull, light yellow color. There was a mild aftertaste and a great balance between the level of alcohol, level of sweetness and fruitiness. Well liked my most panelists.

Treatment 30- sample soaked in 30° Brix sucrose solution. Panelists unanimously agreed that this sample had the best color of all four treatments. The sample was described as bright with a light yellow tint. The sweetness was mild and some panelists mentioned that it could have been sweeter. There was a mild fruity scent but a yeasty scent was also noted. There was a strong alcohol taste and there was a burning sensation noted upon swallowing with a lingering aftertaste. The sample was generally well accepted among panelists.

Treatment 50 (Sample soaked in 50°Brix) – Panelists commented that this was indeed the sweetest sample of all four treatments. The sample was clear, dull and dark yellow. It was the darkest sample of all four treatments and had the lowest alcohol of the samples. A fruity scent was detected and a fruity taste was detected in this sample. A mild aftertaste was also noted. This was a highly preferred wine among panelists.

Treatment 65 (soaked in 65°Brix) - Panelists commented on the high yeasty scent with a faint fruit scent for this sample. This was slightly sweet with very strong alcohol content. The sample was quite clear, with a dull yellow tint. Panelists commented on a string burn upon swallowing the sample with a string aftertaste. This was the least preferred of all four samples.

Ultimately, T0 and T50 were the two samples chosen for further Physicochemical analysis and Sensory quality evaluation as there was a preferential consensus among the group (See Fig 3).

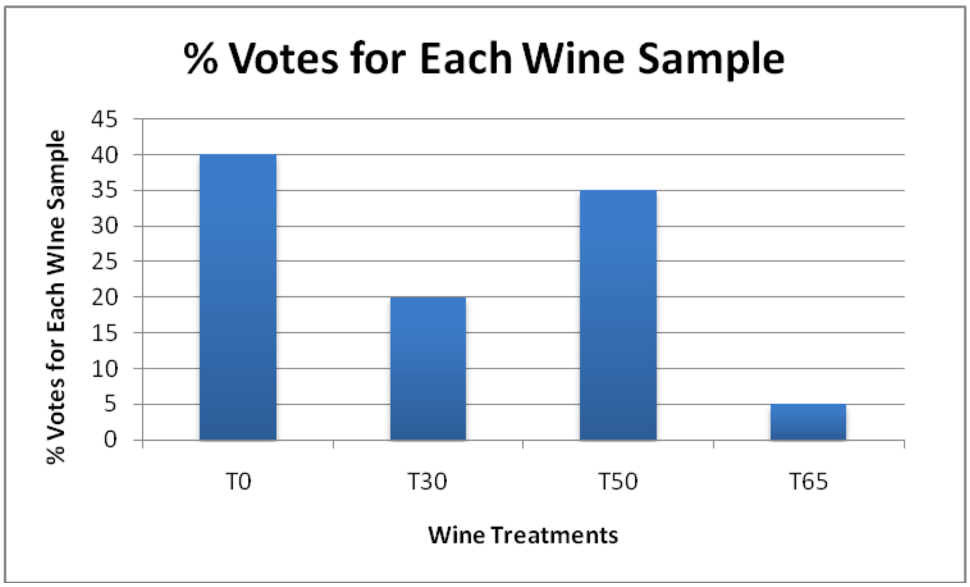

Fig 4- % votes for the different wine samples from the focus group session.

There was a clear preference for T0 and T50 and as such, those two treatments were used for the quality evaluation session.

Sensory Quality Evaluation

There was a significant difference between the mean scores of the samples. Quality is a composite response to the sensory properties of wines based on one's expectations for a given wine type which are a function of one's previous experience with wines (Noble, 1988).

Table 2- Wine scores for each treatment during sensory quality evaluation

Parameter	**T0**	**T50**	**P**
Overall Wine Quality Scores	21.687 (0.72)	24.938 (0.99)	0.01
Gender			
Male (22-36)	20.38 (1.15)	25.13 (1.66)	0.05
Female (22- 36)	23.00 (0.68)	24.75 (1.21)	0.85

There was a significant difference between the mean score of the wines. Sample 1 (T0) had an average score of 21.68 and sample 2 (T50) had an average score of 24.93 out of a possible 34 and are both considered a standard wine (standard 19-26).

There was a significant difference in the scoring of the wines by gender with a 10% significance level and revealed that both men and women scored the sweeter wine T50 higher than T0.

Table 2- Table showing Wine Features and the respective scores from Sensory quality evaluation

Feature	**T0**	**T50**	**P**
Appearance& Color	3.00(0.19)	3.62 (0.20)	0.00
Aroma & bouquet	4.06 (0.23)	4.00 (0.33)	0.00
Acidity	2.12 (0.15)	2.18 (0.13)	0.00
Balance	2.00 (0.13)	2.56 (0.21)	0.00
Body	2.31 (0.15)	2.25 (0.21)	0.08
Flavor	3.37 (0.16)	4.18 (0.21)	0.00
Finish	2.12 (0.15)	2.37 (0.18)	0.30
Overall Quality	2.87 (0.08)	3.56 (0.25)	0.01

There were significant differences ($P<0.00$) between most of the wine features. There were no significant differences in the scores attributed to the body and finish features between wine samples.

Fermentation

Table 3 – Changes in physicochemical characteristics during fermentation

Parameters	Fresh Bilimbi	Osmotic Dehydration	Primary Fermentation	1st racking	2nd racking	P
pH	2.10(0.09)	2.01(0.03)	3.11(0.00)	3.23(0.01)	3.48(0.02)	0.00
TTA (% Citric Acid)	0.75(0.01	0.81(0.03)	0.42(0.00)	0.44(0.00)	0.40(0.00)	0.00
L	42.25(2.34)	51.89(0.97)	24.89(0.32)	27.90(0.19)	26.98(0.13)	0.00
Chroma	21.11(2.28)	27.26(0.97)	1.60(0.07)	0.75(0.07)	0.62(0.08)	0.00
Hue °	110.77(3.03)	101.97(1.07)	105.94(1.21)	96.30(6.97)	65.63(8.75)	0.00

pH

There has been a significant (P <0.01) change in the pH throughout the different fermentation stages. The pH level was adjusted within the range needed to facilitate successful fermentation (3.0- 3.5), with 0.1 N NaOH prior to primary fermentation. After the ph was adjusted, it showed that there were still significant differences (P<0.01) in the pH as fermentation continued.

TTA (Total Titratable Acidity)

There has been significant changes of the total titratable acidity throughout the different stages during fermentation ($P<0.01$). The pH is closely related to total acidity as they are interdependent and the adjustment of either parameter will affect the other but the inverse relationship that they share is quite complex (Pambianchi, 1999).

Color

There were significant changes in the L values during fermentation ($P <0. 00$) which indicated that the color of the wines got darker (lower L values). From the initial color of bilimbi fruits to the end of fermentation, hue became more ($P < 0.01$) orange (lower H), Chroma was less intense ($P < 0.01$; lower C values). Hue denotes shade or tint and the values 0, 45, 90, 180 and 270 represents bluish red, orange, yellow, green and blue respectively. The Hue value ranged from an initial greenish – yellow color and got closer to orange – yellow at the end of the second racking.T3 (50°Brix) showed the lowest Hue° as there was a mean of 37.3(21.0) which would have a indicated a reddish tint. It was noted as the darkest of the samples and found to be quite dull. However, statistically, there was no significant ($P >0.05$) difference between the Hue values between the samples at the end of fermentation.

TSS (°Brix)

The °Brix was considered over several stages and significant changes (P <0.01) were identified. Initially, the fruits were soaked in an Osmotic sucrose solution which significantly (P <0.05) affected the °Brix level of the fruit musts. The °Brix was adjusted to 25° for all samples and after fermentation; there was a subsequent significant difference in the °Brix Level as the sugar available was converted to alcohol.

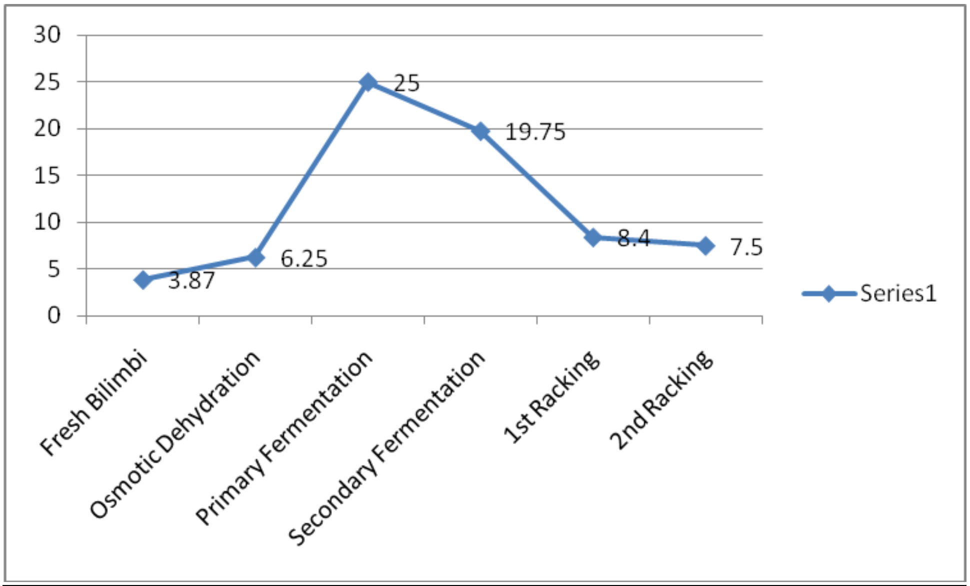

Fig. 5- Changes in °Brix levels at the different stages of fermentation

.

Table 4- Physicochemical changes for each wine treatment during fermentation

Treatment	pH	Mean – TSS	TTA	L	C	H
T0	2.97(0.33)	14.47 (3.76)	0.81 (0.03)	32.40 (2.76)	6.84 (3.06)	89.10 (5.33)
T30	3.00(0.30)	14.67 (3.53)	0.42 (0.00)	33.18 (3.56)	8.04 (3.58)	88.41 (7.29)
T50	2.93(0.31)	15.53 (3.16)	0.44 (0.00)	33.06 (3.69)	7.29 (3.38)	93.6 (11.2)
T65	2.93(0.34)	15.13 (3.43)	0.40 (0.00)	33.04 (3.34)	8.08 (3.79)	98.67 (2.68)
P	**0.31**	**0.18**	**0.26**	**0.99**	**0.99**	**0.73**

There were no significant differences ($P<0.05$) in the physicochemical characteristics between the samples during fermentation.

Table 4- Physicochemical differences between wine samples at final racking.

Treatment	pH	TTA	TSS
T0	3.52	0.40	7.0
T30	3.51	0.39	7.0
T50	3.43	0.42	9.0
T65	3.47	0.38	7.0

Table 5- Color differences between samples at final racking.

Treatment	L	C	H
T0	26.90 (0.15)	0.57 (0.03)	85.53 (6.00)
T30	26.93 (0.08)	0.98 (0.21)	50.3 (12.4)
T50	26.85 (0.29)	0.37 (0.08)	37.3 (21.0)
T65	27.26 (0.47)	0.58 (0.11)	89.31 (7.68)
P	**0.75**	**0.06**	**0.05**

Osmotic dehydration and pH at final racking

The mean pH of the fresh fruits was 2.10 (±0.09) and after osmotic dehydration (O.D), the pH changed to:

Table 6- Differences in pH among samples at final racking

Sample	**pH- after O.D**	**pH adjustment**
T0	2.01	3.12
T30	2.11	3.14
T50	2.02	3.10
T65	1.93	3.11

It shows that after osmotic dehydration, T30 had the highest pH and maintained the highest pH after pH adjustment. T50 had the lowest pH after osmotic dehydration and after pH adjustment.

This difference in pH may have had different effects on the Wines.

The pH and Wine Color (at final racking)

There were significant differences in Hue and Chroma at a 10% level of significance (Table 5). The L values showed that with higher °Brix solutions, the color generally got lighter (higher L values).

Additionally, the sample (T30) which was identified by the Focus group participants as having the best color of all four samples had the highest pH level (after adjustment). There was a mean Hue° of 50.3 which indicated that there was a yellow tint and the Chroma, which was the highest of all three samples (0.98) indicates that sample T30 had a more intense in color.

Sample T50 had the lowest Hue value of all the samples. The Hue value was a mean of 37.3 (21.0) which indicate that it was closer to orange which the other samples had tints closer to yellow. Sample T50 also had the lowest pH level when compared to the other samples was noted to be the darkest color of all three.

It is crucial to highlight that after osmotic dehydration, the pH of sample T30 was the only sample to increase the acidity of the fruits while the pH was reduced in the other samples. It is possible that Osmotic dehydration is most efficient in a concentration of 30° Brix solution.

pH and TSS

The sample with the lowest pH (Sample T50) had the highest level of TSS (°Brix) (Table 4). This may not have been the optimal pH level to facilitate fermentation and as such, there was a higher level of residual sugar in this wine sample 9 ° Brix.

.

Relationships between sensory quality results from focus group and physicochemical results

The focus group engaged in a quality evaluation on two samples T0 and T50 (See Table 3). They preferred the T50 sample which was reflected in the scoring of the different wine features.

Panelists identified T0 as the brighter sample of the two. The T0 had a higher Chroma value, which means the color was more intense than the T50 sample. Also, the Hue° value was higher for T0 was closer to yellow while the Hue° was closer to orange (Table 4).

There was a significant difference in the acidity scores for both wine samples. According to the Physicochemical results (Table 4), the pH for T0 was slightly higher than for T50 but there was a noticeable difference when panelist tasted the wine.

The Flavor of the wines had a significant difference as T50 was significantly sweeter than T0 as shown by the higher residual °Brix level. (Table 4) . Balance, which referred to the acid / sweetness ratio, was significantly different for panelists which reflected in the scores. The physiochemical results supported this as T50 was significantly sweeter and T0 was more acidic.

Conclusion & Recommendations

Color differences were the most significant physicochemical difference between the osmotically dehydrated samples in the production of the wines. A sucrose solution of 30°Brix yielded the brightest and most preferred color as reveled from the consensus made during the Focus Group discussion.

The wines scores also revealed that the wine treatment (T50) with the highest residual °Brix (9) gave a sweeter wine that was much preferred as this wine was scored higher (21.68) than T0 (24.93) when judged for overall quality (Table 1 and 2).

The pH played a significant role in the end product of the wines as it impacted on both color and residual Brix level. The sample with the lowest pH of all four resulted in a darker and sweeter wine.

Osmotic dehydration should be considered prior to wine making to adjust pH levels of high acid fruits prior to fermentation. A °Brix sucrose solution above 30° did not significantly influence pH and still yielded a much preferred wine color among panelists and could be considered as a suitable concentration for adjusting the pH of high acid fruits.

Ultimately, contrary to the view that sub tropical and tropical fruits have low acidity and are difficult to make into attractive, stable wines (Amerine et al., 1980) the Bilimbi wines selected for further work T0 and T50 produced well accepted standard (Score for standard wine rating 19-26) wines according to the scoring done by trained panelists.

References

Agudo, A., Cabrera, L., Amiano, P., Ardanaz, E., Barricarte, A., Berenguer, T., Chirlaque, M.D., Dorronsoro, M., Jakszyn, P., Larranaga, N., Martinez, C., Navarro, C., Quiros, J.R., Sanchez, M.J., Tormo, M.J., Gonzalez, C.A., 2007. Fruit and vegetable intakes, dietary antioxidant nutrients, and total mortality in Spanish adults: findings from the Spanish cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC-Spain). American Journal of Clinical Nutrition 85 (6), 1634– 1642.

Amerine M.A. and Singleton V.L. 1968. Wine: An Introduction for Americans. University of California Press. Los Angeles. USA.

Andrews L. and Ragoonath J. (1990). Carambola and bilimbi, Fruits 45. pg 497–501.

Anonymous, Official methods of analysis, 13th ed., AOAC, Blackie Acad. Prof., London, UK, 1980.

Anonymous, Official methods of analysis, 15th ed., AOAC, Blackie Acad. Prof., London, UK, 1990.

Bradley R.L. 1998. Moisture and total solids analysis, in: Nielsen S. (Ed.), Aspen Publ., Gaithersburg, USA.

Bridgebassie, V. and Badrie, N. 2004. Effects of pectolase concentration and yeast strains on carambola wine quality in Trinidad, West Indies. Fruits, vol. 59, p. 131–140.

Corrêa, M. P. 1926. Diccionario das Plantas Úteis do Brasil e das Exoticas Cultivadas. Rio de Janeiro: Imprensa Nacional. pg307.

Chambers , E., IV and Smith , E. A. 1991. The use of qualitative research in product research and development .In Sensory Science Theory and Applications in Foods . H.T. Lawless and B.P Klien, eds. Marcel Dekker, New York, Basel , and Hong Kong. Pg. 395-412.

Goh, S.H., Chuah, C.H., Mok, J.S.L., Soepadmo, E., 1995. Malaysian Medicinal Plants for the Treatment of Cardiovascular Diseases given with extracts of *A. bilimbi* fruits and leaves. Pelanduk, Malaysia. pg. 63

Gray AM, Flatt PR. Nature's own pharmacy: the diabetes perspective. Proceedings of the Nutrition Society 1997; 56: 507–17.

Harris, R. S. 1977. Effects of agricultural practices on foods of plant origin. In: Harris, R. S.; Karmas, E. Nutritional evaluation of food processing. Connecticut: The AVI Publishing Company. pg. 670

Hu, F.B., 2003. Plant-based foods and prevention of cardiovascular disease: An Overview. American Journal of Clinical Nutrition 78, 544S–551S.

Huxley, R.R., Neil, H.A., 2003. The relation between dietary flavonoids intake and coronary heart disease mortality: a meta-analysis of prospective cohort studies. European Journal of Clinical Nutrition 57, 904–908.

Ikram, E.H.K., Eng, K.H, Jalil, A.M.M., Ismail, A., Idris S., Azlan, A., Nazri, H.S.M., Diton, N.A.M., Mokhtar, R.A.M. 2009. Antioxidant capacity and total phenolic content of Malaysian underutilized fruits. Journal of Food Composition and Analysis. YJFCA-1825.

Jackisch, P. 1985. Modern wine making. Cornell University Press. USA.

Jackson, R. 2002. Wine tasting: A Professional Handbook. Academic Press. London.UK

Joshipura, K.J., Hu, F.B., Manson, J.E., Stampfer, M.J., Rimm, E.B., Speizer, F.E., Colditz, G., Ascherio, A., Rosner, B., Spiegelman, D., Willett, W.C., 2001. The effect of fruit and vegetable intake on risk for coronary heart disease. Annals of Internal Medicine 134 (12), 1106–1114.

Krueger R.A, Casey, M. 2000. Focus groups 3rd edition, a practical approach for applied research. Sage Publications. California. USA.

Lenart, A. & Flink, J.M. 1984. Osmotic dehydration of potato 1. Criteria for end point of osmosis process. Journal of Food Technology, 19, 45–63.

Lenart, A. 1992. Mathematical modelling of osmotic dehydration of apple and carrot. *Acta Alimentaria Polonica*, 1, 33–44. 15.

Lima, V.L.A., Mélo, E., Lima, L. 2001. Physicochemical **Characteristics** of bilimbi (*Averrhoa* ***bilimbi*** **L.).** Rev. Bras. Frutic., Jaboticabal - SP, v. 23, n. 2, p. 421-423.

Lawless H., Heymann H., 1998. Sensory evaluation of food: principles and practices, Chapman and Hall, New York, USA.

Mathew, L., George, S. T., Babylatha, A. K.; Geetha, C. K. 1993. Flowering and fruit development in bilimbi (*Averrhoa bilimbi* L.). South Indian Horticulture, Kerala, v.41, n.1, p.41-42.

Maynard, A A., Berg, H.W., Cruess, W.V. 1980. The technology of Wine making. Westport, Conn. AVI Pub. Company.

Meilgaard M., Vance G., Carr B.T., 1999. Sensory evaluation techniques, CRC Press Inc., Florida, USA.

Meilgaard, M., Vance G., Carr B.T. 1991. Sensory evaluation techniques, CRC Press Inc., Florida, USA.

Morton J. 1987. Fruits of warm climates. Media Incorporated, Greensboro, North Carolina, USA.

Noble A.C. 1988. Analysis of wine sensory properties, in: Linskens H.F., Jackson J.F., Wine analysis, Springer-Verlag, New York, USA.

Pambianchi, D. 1999. Techniques in home winemaking: a practical guide to making château-style wines. Montréal : Véhicule Press.

Raoult-Wack, A.L., Lafont, F., Rios, G. & Guilbert, S. (1989) Osmotic dehydration. Study of mass transfer in terms of engineering properties. In Drying ’89. (ed. By A.S. Mujumdar & M. Roques), pp. 25–30. Hemisphere Publishing, New York, USA.

Raoult-Wack, A.L., Cuilbert, S., Le Maguer, M. & Rios, G. (1991) Simultaneous water and solute transport in shrinking media. Part 1. Application to dewatering and impregnation soaking process analysis (osmotic dehydration). Drying Technology, 9, 589–612.

Raoult-Wack, A.L., Guilbert, S. & Lenart, A. (1992) Recent advances in drying through immersion in concentrated solutions. In Drying of Solids (ed. by A.S. Majumdar. International Science Publishers, New York.USA.

Resurreccion, A. 1998. Consumer Sensory Testing for Product Development. Aspen Publishers, Maryland, USA.

Riboli, E., Norat, T. 2003. Epidemiologic evidence of the protective effect of fruit and vegetables on cancer risk. American Journal of Clinical Nutrition 78 (3), 559S–569S.

Salvatori, D. & Alzamora, S.M. (2000) Structural changes and mass transfer during glucose infusion of apples as affected by blanching and process variable. Drying Technology, 18, 361–382.

Talens, P., Escriche, I., Martinez-Navarrete, N. & Chiralt, T.A. 2002 .Study of the influence of osmotic dehydration and freezing on the volatile profile of strawberries. Journal of Food Science, 67, 1648–1653.

Tan, B.K.H., Fu, P., Chow, P.W., Hsu, A. 1996. Effects of A. bilimbi on blood sugar and food intake in streptozotocin–induced diabetic rats. Phytomedicine 3, 271

Torreggiani, D. 1993. Osmotic dehydration of fruit and vegetable processing. Food Research International, 26, 59–68.

Wee Yeow Chin. 1992. Editor: A guide to medicinal plants. Singapore: Singapore Science center.

Wong, K. C.; Wong, S. N. 1995. Volatile constituents of Averrhoa bilimbi L. fruit. Journal of Essential Oil Research, Carol Stream, v.7, n.6, p.691-693.

Yang, D.C. & Le Maguer, M. 1992.Mass transfer kinetics of osmotic dehydration of mushrooms. Journal of Food Processing and Preservation, 16, 215–231 .

Francis F.J. 1998.Color analysis, in: Nielsen S.S. (Ed.), Food Analysis, Aspen Publ., Unc., Gaithersburg, USA.

Appendices

1. Focus Group sensory evaluation Form

2. Sensory Quality evaluation form

Sensory Evaluation of Bilimbi Wine

Focus group discussion

Panelist # ……………………   Date ………………………..

1. Please indicate your sex
   ( ) Male   ( ) Female

2. What is your age?

   ( ) 18- 25   ( ) 26- 35   ( ) 36- 50   ( ) over 50

3. Do you know what Bilimbi was prior to this focus group session?
   ( ) Yes   ( ) No

4. If yes, in what forms have you used Bilimbi?
   ( ) Pepper sauce ( ) Pickled ( ) Fresh ( ) Jams/ jellies ( ) Chutney ( ) other

5. Have you ever tasted Bilimbi wine?
   ( ) Yes   ( ) No

6. Have you ever tasted carambola (five fingers) wine?
   ( ) Yes   ( ) No

7. How often do you consume wine?

   ( ) Daily   ( ) Weekly   ( ) Monthly   ( ) Occasionally

8. What type of wine do you prefer?

   ( ) Sweet   ( ) Dry   ( ) White   ( ) Red

Sensory Evaluation of Bilimbi Wine - **Focus group discussion**

Please comment on the following aspects as it pertains to the wine:

Color and clarity:

Aroma:

Taste and flavor:

Sweetness:

Alcohol content:

Overall acceptability:

Which two (2) samples did you prefer?

( ) 549   ( ) 928   ( ) 306   ( ) 725

If this wine was bottled and marketed, would you purchase it?

____
____
____

Sensory Evaluation of Bilimbi Wine

Quality evaluation and Wine Scoring session

Panelist …………………… Date ………………………..

9. Please indicate your sex

( ) Male ( ) Female

10. What is your age?

( ) 18- 25 ( ) 26- 35 ( ) 36- 50 ( ) over 50

11. Do you know about Bilimbi prior to this session?

( ) Yes ( ) No

12. If yes, in what forms have you used Bilimbi?

( ) Pepper sauce ( ) Pickled ( ) Fresh ( ) Jams/ jellies ( ) Chutney ( ) other

13. Have you ever tasted Bilimbi wine?

( ) Yes ( ) No

14. By choosing either a, b or c state within a month how often do you consume wine and in what portion each time?

a) ( ) Daily ………………….ml per serving

b) ( ) Weekly ……………………ml per serving

c) ( ) Occasionally ……………………ml for the month

15. What type of wine do you prefer?

( ) Sweet ( ) Dry ( ) White ( ) Red

Wine quality evaluation score sheet

Name: ________________________ Date: ___________________

Sample # ______________________

Feature	*Description*	*Score*
Appearance and color		
1	POOR- slightly off- color	
2	ACCEPTABLE- Dull color	
3	GOOD- Appropriate characteristic color	
4	SUPERIOR-Bright with characteristic color	
5	EXCEPTIONAL-Brilliant with characteristic color	
Aroma and bouquet		
1	FAULTY- Clear expression of an off-odor	
2	OFF CHARACTER- Marginal expression of an off odor	
3	ACCEPTABLE-No characteristic fragrance or bouquet	
4	PLEASANT- Mild characteristic fragrance or bouquet	
5	GOOD- Standard presence of a characteristic fragrance or bouquet	
6	SUPERIOR- Distinct and complex characteristic fragrance or bouquet	
7	EXCEPTIONAL- Rich refined characteristic fragrance or bouquet	
Acidity		
1	POOR- Acidity either too high (sharp) or too low (flat)	
2	ACCEPTABLE- sufficient amount of acidity for wine style	
3	GOOD- Acidity appropriate for the wine style	
Balance		
1	POOR- Acid/sweetness ratio inharmonious ; excessively bitter and astringent	
2	GOOD- Acid/ sweetness ratio inadequate ; moderate bitterness and astringent	
3	EXCEPTIONAL- Acid/sweetness balance invigorating; smooth mouth feel	
Body		
1	POOR- Watery or excessively alcoholic	
2	ACCEPTABLE- moderate balance between watery and alcoholic	
3	GOOD- Typical feeling of weight (substance) in mouth	
Flavor		
1	FAULTY- off taste of off- odors so marked as to make the wine distinctly unpleasant	
2	POOR- absence of flavor characteristic in the mouth	
3	ACCEPTABLE- slight presence of flavor characteristic in the mouth	
4	GOOD- presence of flavor characteristics in the mouth	
5	EXCEPTIONAL- superior expression of flavor characteristics in the mouth	
Finish		
1	POOR- Little lingering flavor in the mouth ; excessive astringency and bitterness	
2	GOOD- moderate flavor in the mouth , pleasant aftertaste	
3	EXCEPTIONAL- Prolonged flavor in the mouth (10 to 15 seconds), delicate and refined aftertaste.	
Overall quality		
1	UNACCEPTABLE- Distinctly of character	
2	ACCEPTABLE- Slightly off character	
3	GOOD- Acceptable representation of traditional aspects of the wine	
4	SUPERIOR- clearly better than the majority of the wines of the type	
5	EXCEPTIONAL- so nearly perfect in all sensory qualities as to be memorable	