CONSUMER ACCEPTANCE OF TROPICAL WINES FROM ALOE VERA (*Aloe barbadensis*) AND CASHEW APPLES (*Anacardium occidentale* L.) IN THE BRITISH VIRGIN ISLANDS

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ABSTRACT

*The production and acceptability of wines produced from Aloe vera leaves (*Aloe barbadensis *Mill) and cashew apples (*Anacardium occidentale *L.) were investigated. Sensory paired comparisons between A. vera sweet wines (8.6-8.65°Brix; 10.60-10.63% alcohol) with A. vera dry wines (3.20-3.30°Brix; 10.35-10.48% alcohol) and cashew sweet wines (9.30-9.50 °Brix, 11.86-11.90 % alcohol) with cashew dry wines (4.10-4.30°Brix; 11.59-11.69% alcohol) indicated a difference ($p<0.05$) in consumer acceptance as an estimate of the market potential. A market segmented preference existed for dry wines by the North American tourists who visit the British Virgin Islands and for sweet wines by the Caribbean consumers. Based on a 5-pt hedonic- score and purchase intent interval scale, both A. vera and cashew wines were 'neither liked nor disliked' to 'liked a little' and with purchase intent of probably buy to maybe/maybe not. Clarity of wines needed improvement based on percent light transmission.*

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INTRODUCTION

The British Virgin Islands (BVI) are located approximately 50 miles east of Puerto Rico within 15 miles of St. Thomas, US Virgin Islands on latitude18° 40N and longitude 64° 30W (Stonehouse 1988). The total land area of the territory is approximately 58 square miles consisting of over 40 islands. The economic structure is highly dependent on tourism, financial services (offshore banking), construction and minimal dependence on agriculture. According to Ahmed and Afroz (1996), tourism is one of the most important sectors of the Caribbean economy, but unfortunately, whatever benefits the industry gain, most of them are not transferred into the national economies, but to foreign hotel chains, airlines and suppliers of imports for the tourists. A survey of the fruit-processing industries in the Caribbean (April-July, 1994) indicated that the majority of the enterprises are cottage or small-scale operations with limited equipment and using inappropriate technologies (Francis 1994). Similarly as reported by Francis (1995), the production of tropical fruit wines and other alcohol-based fruit beverages from a variety of fruits in the Caribbean is limited to cottage and small - scale enterprises in Trinidad and Tobago, Dominica, St. Lucia, St. Vincent and the Grenadines.

Cashew (*Anacardium occidentale* L.) and Aloe vera (*Aloe barbadensis* Mill) grow abundantly in wild stands in the British Virgin Island but remain under-utilized (Muir-Beckford 1999). Aloe vera is also known as Mediterranean, Curacao or Barbados aloe belongs to the family Liliaceae (Mohammed 1996). The key problem limiting the acceptability of the cashew apples is its astringency (Ortiz *et al.* 1982). Also, the seasonal nature of the perishable cashew apples has been one of the greatest handicaps for the processing industry (Ohler 1979). Processing of fruits extends the season of perishable crop. Preservation provides a shelf-stable product but usually at the cost of color, flavor and texture (Salunkhe *et al.* 1991). Stemming the demise of the agricultural sector in the BVI, value can be added to cashew apples and A. vera leaves in the production of "exotic" tropical wines thus providing a strategy for the production of higher valued agricultural products directed at niche markets and aid in the diversification of the agro-economic base. The objectives of this study were to evaluate the physicochemical and microbiological quality of the wines, to determine the level of acceptance and to assess consumer willingness to purchase of these wines.

MATERIALS AND METHODS

Materials

Figure 1 shows the processing steps in the production of cashew and Aloe vera wines. Ripe cashew (*Anacardium occidentale* L) apples of the yellow variety were

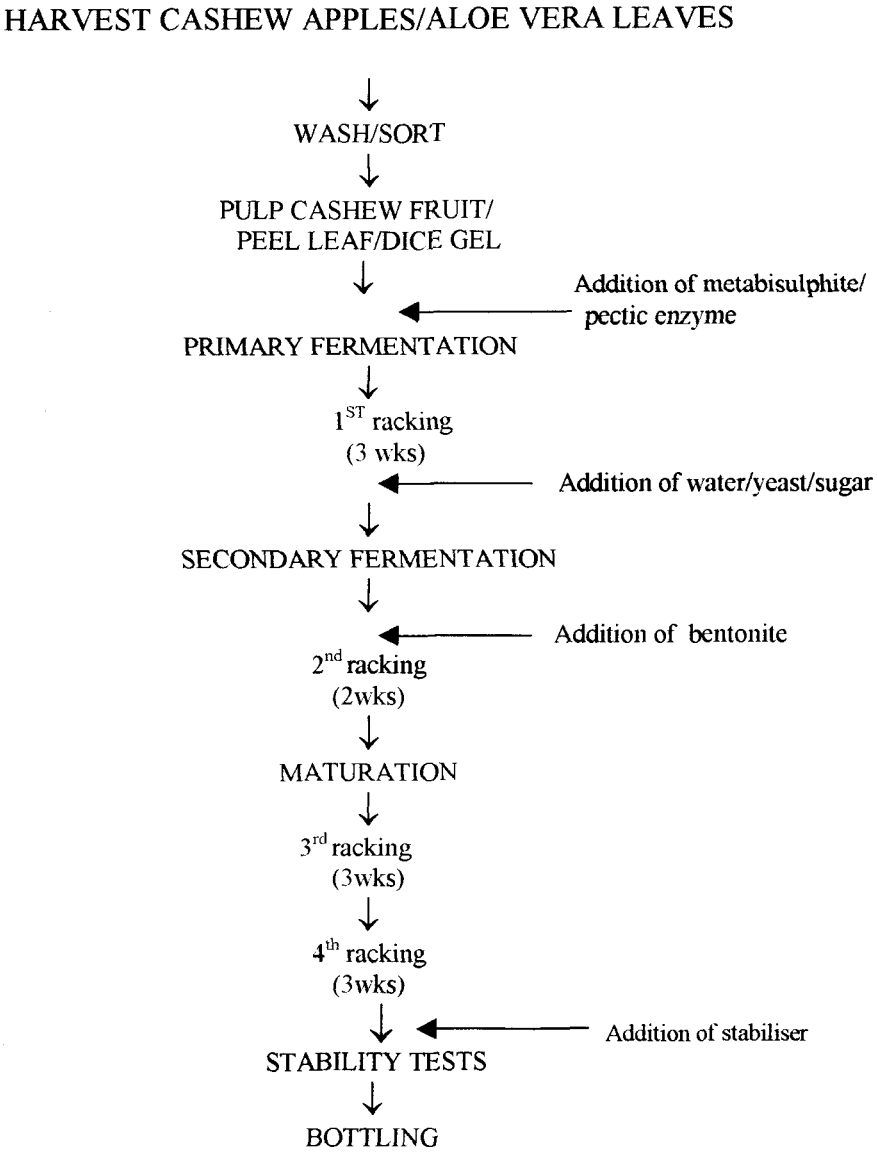

FIG. 1. PROCESSING STEPS IN ALOE VERA AND CASHEW WINE PRODUCTION

harvested from wild stands and the nuts removed. According to Ogunmoyela (1982), the unripe cashew is astringent and slightly acid but when ripe, it is juicy, sweet and edible. The fruits were washed (100 ppm chlorine), diced and blended into a pulp (Hamilton-Beach/Proctor-Silex, Model # 50100-B12, Washington, NC) and frozen at -10C. *A. vera* leaf blades (50 cm long X10 cm long) were harvested form wild stands, by cutting the leaves from the plant. They were washed in chlorinated water (500 ppm). The rubbery epidermis was removed by peeling and the gel (semitransparent) cut into 3 cm^3 to be used in the production of wines.

Fermentation

For cashew wine production, cashew pulp (67%), sterilized water (5 L) and sodium metabisulphite (50 ppm) were left for 24 h in 23-liter food grade polyethylene buckets. Pectic enzyme, 0.02% (LD Carlson Co., Ohio) was added and left for a further 24 h. The pH of must was adjusted from an initial pH of 4.7-5.1 to pH 3.5 with citric acid Granulated sucrose was added to adjust the total soluble solids from an initial 5.5°Brix of cashew pulp to either 21°Brix for dry wines or to 23°Brix for sweet wine production. Yeast, (0.3%) *Saccharomyces cerevisiae* var.ellipsoideus (Unicam Co., Norwich, England) with Becoplex constitutents of Vitamins B1(10 mg), B2 (3 mg), B6 (1 mg), B12 (mcg) and C (50 mg) and diammonium phosphate with ammonium phosphate (2.2%) were added to the must. The starter culture was made by allowing the yeasts to grow in must (500 g) for 48-72 h as recommended by Cariri (1992). Sterilized water was added to obtain a final volume of 4 L, and allowed to ferment for three (3) weeks at 23C. Wines were siphoned into 4.5 L plastic bottles, to which was added bentonite slurry (5 g/100 mL water) and sodium metabisulphite (50 ppm). A second racking was done after 2 weeks and a third and fourth on week 5 and week 8 of secondary fermentation, to which was added sodium metabisulphite (100 ppm).

The same steps for aloe vera wine production were followed as for cashew wine with exceptions as indicated. To aloe vera gel cubes (26%), cooled sterilized water (5 L) was added in the 23 liter buckets with sodium metabisulphite (50 ppm,) and left for 24 h. Pectic enzyme (0.02%) was added and left for additional 24 h. The pH of the must was adjusted from 5.4 -5.5 to a final pH 3.5 by addition of citric acid. Granulated sucrose were added to increase the total soluble solids of the must from 1.8°Brix to 21°Brix for dry wines and 23°Brix for sweet wines.

Aging and Stability Tests

Aging was done in 4.5 L bottles as suggested by Berry (1996). The bottles were stored in the dark at 18C for 8 weeks after which stability tests were conducted as described by Peynaud (1984). Amerine *et al.* (1980) indicated that quality is best preserved and enhanced if aging is done below 21.1C. Wines were heated in a water bath to 80C for 10 min and observed at 32C (ambient temperature) for 24 h.

Following this treatment, the wine treatments were stored at 0C for further 24 h and then exposed to indirect sunlight for 7 days. Wines were held for alternate 24 h period at 42C or at 32C.

Chemical Analyses

Analyses were conducted in triplicate on all wine treatments. Experiment was replicated. Alcohol content was determined by the refraction index of the distillate using an immersion refractometer (ABBE-60, Bellingham and Stanley, Kent, England) as outlined in procedure #920.58 (AOAC 1990). Total soluble solids (TSS) as °Brix was determined on the must and wines using a temperature-compensated hand-held refractometer (Leica Model, Atago E Type Series, Leica Inc., Buffalo, NY) as outlined by Bradley (1998). The pH of wines was measured on an Orion pH meter (model 520A, Orion Research Inc., Beverly, MA) using a buffer solution of pH 7.41.Total acidity (TAA) was determined by titration using 1N NaOH and phenolphthalein indicator solution as outlined in procedure #962.12 (AOAC 1990). Clarity as percent light transmission was measured using a spectrophotometer (Model C099-0993, Lambda 3B dual beam UV/VIS, Perkins-Elmer Inc, Altamara, San Juan, Puerto Rico) as outlined by Vine (1981). The reading was taken at 425 nm.

Microbiological Analyses

Total plate count, yeast with molds and lactic acid bacteria were enumerated. Serial dilutions of wine samples were prepared on media (Oxoid, Hampshire, England) by the pour plate method. Plate Count Agar (PCA), Potato Dextrose Agar (PDA) and Tomato juice agar (TJA) media were used in the enumeration of total count of microorganisms, yeast and molds and lactic acid bacteria respectively. Media plates were incubated at 35±2C for 48 h for PCA, 30±2C, TJA plates and PDA plates at 28±2C for 24 h according to the methods of Benson (1985).

Sensory Evaluation/Purchase Intent

A consumer-oriented sensory evaluation was conducted on all wines (both sweet and dry Aloe vera and sweet and dry cashew wines). Volunteers for the sensory panel were solicited from restaurants on the island of the Virgin Gorda. A central-location sensory evaluation was conducted at four venues. Consumer testing of wines was replicated. In the first stage of sensory evaluation, fifty-five (55) consumers (untrained panelists) were used and in the other session 50 consumers (untrained panelists). Panelists were all wine drinkers from the British Virgin Islands and tourists from the United States of America who were willing to participate in the exercise. All of the Caribbean panelists were of African heritage and the tourists were Caucasians. Panelists were between the ages of 21-

55 years. For central location tests, the consumer acceptance is a small panel usually involving 50-100 panelists (IFT/SED 1981) or the number may range from 50 to 300 (Meilgaard *et al.* 1991). The primary purpose of the consumer affective tests was to assess the personal response by current and potential customers of a product (Resurreccion 1998), by determining the acceptability or liking for a food by consumers (Stone and Sidel 1985). Each panelist was instructed as to the completion of the questionnaire. According, to Watts *et al.* (1989), trained panelists should not be used for acceptance tests.

In the first stage of sensory evaluation, each panelist was given four (4) wine samples: A. vera sweet wine, A. vera dry wine, cashew sweet wine, and cashew dry wine in one session. All wine samples were coded with 3-digit random numbers and served on a tray. According to Vine (1981), eight wines are considered to be the most to be evaluated accurately at any one sitting. Each wine sample (20 mL) was served chilled (18-20C) in long-stemmed balloon-shaped wine glasses (6 oz or 170 mL). Peynaud (1984), suggested the use of balloon or tulip-shaped glasses with a stem as being ideal for wine tasting, as they allow a concentration of the odor directly above the wine's surface when making comparisons, and indicated that the glasses should be filled the same way for making comparisons. The temperature of serving the wine is important, as tannins are less obvious at low temperatures (18-20C), but the wine may appear more alcoholized (Meilgaard *et al.* 1991). Wines also appear less acidic. Panelists were instructed to neutralize the palate between samples using water, cheddar cheese and unsalted biscuits as suggested by Vine (1981). Consumer-acceptance was based on a five-point hedonic score (1-dislike lot; 2-dislike a little; 3-neither like nor dislike; 4-like a little; 5-like a lot) as described by Watts *et al.* (1989). According to Peynaud (1984), hedonic tasting is conducted for the pleasure of drinking it. In another session, a paired preference test on two coded samples either a sweet cashew wine with a dry cashew wine or sweet A. vera wine with a dry A. vera wine was presented simultaneously in random order. Two possible orders of presentation were presented an equal number of times. Panelists were asked to indicate their preference. According to Stone and Sidel (1985), the test may involve more than one pair of samples.

After, scoring the wines, panelists answered questions concerning (1) consumer purchase intent (1-definitely buy, 2-probably buy, 3-may be/maybe not, 4-probably buy and 5-definitely not buy), (2) how often would they buy the wine (once; twice; three times; > three times), (3) how many bottles would they buy each time (1; 2; 3; >3 bottles), (4) what is the most suitable price per bottle (US$ 4-6; 7-9; 10-12; 12) and (5) how would they utilize the wines at their homes.

The scores were analyzed using Minitab Statistical Software, 12 for window (Minitab Inc., State College, PA). T-test and test for normal distribution were conducted on the means.

RESULTS AND DISCUSSION

Physicochemical Quality

Table 1 shows the results of the quality analyses for the different wines. According to a classification by Cariri (1992), the alcohol content of all the wines can be categorized as table wines as they were within the range of 9-12% v/v. According to Peynaud (1984), the vinosity of a wine is hardly apparent at less than 11.5% alcohol. Cashew apples were more acidic (pH 4.7-5.10) as compared to A. vera gel (pH 5.4-5.5) which can be related to the differences in total titratable acidites of wines (Table 1). Ohler (1979) recommended the addition of citric acid or lime juice to be added to the must just before fermentation. There was better clarity (percent light transmission) in A. vera wines as compared to cashew wines, however the clarity of cashew wines needed improvement based on percent light transmission. Based on stability tests on experimental wines, there were no changes in clarity thus indicating that the wines should remain stable during storage. Treating the must with bentonite (a fining agent) would have helped to eliminate proteins in the must which tend to precipitate and cloud the wine. According to Peynaud (1984), clarity is the brilliant appearance of the wine, absence of cloudiness, haze or precipitation.

TABLE 1.
QUALITY OF ALOE VERA WINES AND CASHEW WINES

Wine Type	Total Acidity, g/100 mL	Alcohol, % (v/v)	°Brix	Specific Gravity	Clarity, % Light Transmission
A. vera, dry	0.50-0.51	10.35-10.48	3.20-3.30	1.022	76.90
A. vera, sweet	0.51-0.53	10.60-10.63	8.60-8.65	1.040	75.40
Cashew, dry	0.60-0.63	11.59-11.69	4.10-4.30	1.023	58.50
Cashew, sweet	0.65-0.67	11.86-11.90	9.30-9.50	1.044	68.70

Cashew pulp 5.50°Brix ; aloe vera leaves 1.8°Brix
dry wine must 21°Brix ; sweet wine must 23°Brix

The cashew apple contains 85% juice, with a sugar content of about 10%. The juice is somewhat astringent, due to its tannin content (Ohler 1979) and there may be considerable differences in sweetness and astringency existing among trees. According to Purseglove (1991), the cashew apple contains about 88% water, less than 0.3% protein and fat and about 11.6% carbohydrate and is rich in vitamin C.

Ogunmoyela (1982) reported that for cashew wine production, the juice is clarified with gelatine and pure wine yeast is then added. After 7-10 days of complete fermentation, the juice has an alcohol content of 4-5%. A stronger wine of higher alcohol content may be prepared by adding sugar before fermentation. Singh *et al.* (1963) indicated that the cashew juice is used for making pleasant wines and that it contains 7-9% sugar and 0.5% tannic acid.

The leaves of A. vera contained free and combined anthraquinones, carbohydrates, and glycosides (Mohammed 1996), 18-25% aloin , resin, emodin and volatile oil and greater than 50% water-soluble matter (Seaforth 1988). Mohammed (1986), reported that the mucilaginous parts of the leaves were found to contain sugars such as glucose, mannose and galacturonic.

Microbiological Analysis

Results of the microbiological analysis for both preliminary and experimental trials indicated less than 10 CFU/mL for total counts of microorganism, yeast and molds and lactic acid bacteria.

Consumer Acceptance

Panelists (69.3%) scored the A. vera wines (both dry and sweet) in the "liked" category of the hedonic scale whereas 23.08% of the respondents disliked the wines (Table 2). For cashew wines (both sweet and dry), 66.8% of panelists give "liked" scores as against 25.9% of the respondents who disliked the wines. A. vera wines were given a mean score of 3.67 and cashew wine a score of 3.74, indicating that both were "neither liked nor disliked" to "liked a little".

TABLE 2.
HEDONIC ACCEPTANCE FOR WINES

Wines	'Liked Category,' % Responses	'Disliked Category,' % Responses
A. vera	69.3	23.1
Cashew	66.8	25.9

Hedonic scores: >3 liked category; <3 disliked category; 3 neither liked nor disliked

There was significant difference in preference ($P<0.05$) between dry and sweet wines of A. vera and cashew by market respondents (Table 3). Dry wines (A. vera wines and cashew wines) were preferred more by the tourists who visited the BVI, (62% and 61% responses, respectively) in contrast to sweet wines (A. vera and cashew) by Caribbean consumers (67% and 80% of the responses, respectively).

Table 1 indicates the differences in chemical quality between dry and sweet wines (dry wines 3.20-4.30 °Brix; 10.35-11.69% alcohol) and sweet wines (8.60-9.50 °Brix; 10.60-11.90% alcohol) which may have accounted for the differences in preference by panelists.

TABLE 3.
PAIRED PREFERENCE FOR WINES

Market	A. Vera Wine, % Responses		Cashew Wine, % Responses	
	Dry	Sweet	Dry	Sweet
Tourist	62	38	61	39
Caribbean	33	67	20	80

Preference was significant ($P<0.05$) between dry and sweet wines in markets

Panelists (51.9%) indicated that they "would buy" A. vera wines versus 25.7% of respondents who indicated that they "would not buy". The purchase intent survey for cashew wines, indicated that 66.7% of the respondents "would buy" as against 21.62% of the respondents who would not buy (Table 4). A. vera wine was given a mean purchase intent score of 2.67 and cashew wine a score of 2.60, indicating that consumers 'may be' to 'may be not' (<3 'would buy' category; > 3 would not buy category; 3 maybe/maybe not buy). The quantity purchased by an average buyer was one bottle (1 bottle purchased once) at an average price of US $4-6 per bottle for A. vera wine and US $7-9 per bottle for cashew wine. Also, the survey indicated that 35% of the respondents would consume the wines as an after dinner dessert wine but would prefer a drier table wine. Some comments by panelists were that the "high" alcohol content of both sweet and dry cashew and A. vera wines were acceptable, the strong fruity flavor and favorable odor of cashew wines were desirable and the astringency of cashew wines was tolerable. Consumer testing is necessary in the assessment of market potential (ASTM 1979). According to Kotler and Armstrong (1996), in the process of new product development, commercialization should follow on favorable test market (product testing) results. An estimate of the market potential can be calculated using the equation of $Q=nqp$ of Kotler and Armstrong (1996), where Q is the total market potential, n is the number of buyers in the specific product, q is the quantity purchased by an average buyer and p is the price.

TABLE 4.
PURCHASE INTENT FOR WINES

Purchase Intent	'Would Buy,' % Responses	'Would Not Buy,' % Responses
A. vera wines	51.9	25.7
Cashew wines	66.7	21.3

Purchase intent: <3 would buy; 3 may be/may be not; >3 would not buy

Implications of the Study

The study indicated that there was a preference for dry wines by North American tourists while Caribbean consumers preferred sweet wines. Most of the respondents indicated that they would buy these exotic tropical wines. The results of the consumer acceptability can provide an estimate of a potential market for these wines. In the process new product development, commercialization follows on favorable test market results (Kotler and Armstrong 1996). This could lead to diversification of the agricultural sector in the BVI, creation of agro-tourism linkages brought about by the cultivation and agro-processing of A. vera and cashew with an increased revenue from agriculture.

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