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CONSTITUENTS OF BRAZILIAN CASHEW APPLE JUICE

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ABSTRACT

Juices from sweet, sour, and astringent cashew apples of both, red and yellow varieties were analyzed by ion exchange, GLC, and other standard methods for free amino acids, sugars, organic acids, ascorbic acid, and tannins. Significant differences were observed, among the most notable being the increased levels of tannins in the astringent apples and the decreased levels of free amino acids in the acidic apples. Malic acid was the predominant organic acid with only small amounts of other organic acids. Ascorbic acid levels ranged from 195-325 mg/100 ml. Increased commercialization of this largely wasted product should be encouraged because of its valuable nutrients.

INTRODUCTION

At present, varieties of the cashew tree, *Anacardium occidentale* L., have not been established, because of the common practice of propagation by seed. The sole means of differentiation has been by the red or yellow color of its false fruit, the hypertrophied peduncle known as the cashew apple. Cashew apples contain large amounts of ascorbic acid, a quantity of tannins, and can be sweet, sour, or astringent to the taste (SASTRY *et al.*,(14)). In general, cashew apples and nuts from a single tree will retain their characteristic color, size, shape, and taste year after year even though they vary greatly from tree to tree (PRICE *et al.*,(13)).

Because of the economic importance of the cashew nut and of its major by-product, cashew nut shell oil, a phenolic, caustic liquid used in plastics formulation, the cashew apple has been largely wasted. Most of the cashew apples which are utilized are consumed fresh, are eaten close to the area of production, and are of the sweet variety. The sour and astringent apples are discarded. It has been estimated that annual losses exceed three million metric tons, or 80% of the world's production (HAENDLER and DUVERNEUIL (3), LOPES(6). Several authors have encouraged the increased commercialization of the cashew apple (PRUTHI *et al.*(9), MAIA *et al.*(7), TREVAS(17), LOPES(6).

The purpose of this study is to examine the chemical constituents of the three classes of cashew apples, sweet, sour, and astringent in greater detail. This should aid in determining factors to be considered in vegetative propagation of the tree and in future processing operations.

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MATERIALS

Mature cashew apples were obtained at the Fazenda Experimental, Ministério da Agricultura, Pacajus, Ceará, Brazil or at the Centro de Ciências Agrárias, Fortaleza, Brazil. They were separated into three different categories: sweet, sour and astringent. Samples not falling definitely into these categories were discarded.

The apples were macerated in a Waring blender and the particulate matter was removed by straining through cheesecloth. The resulting turbid juice was frozen and stored at — 20°C until analyzed.

METHODS

Standard AOAC procedures(1) were used for determination of Kjehdahl nitrogen (protein conversion faction 6.25), titratable acidity, pH, tannins expressed as tannic acid, and ascorbic acid (dichloroindophenol method). Reducing sugars were determined using the method of "Normas Analíticas do Instituto Adolfo Lutz"(10). Soluble solids were determined at 25°C using a Bausch and Lomb refractometer calibrated in degrees Brix.

Quantitative analysis for free amino acids were made on a Beckman Model 121 amino acid analyzer according to the method of Moore and Stein(8) as modified by SPACKMAN *et al.*(15) or on a Technicon Auto Analyzer according to the procedure of PIEZ and MORRIS(12). Juice was clarified by centrifugation at 4000 rpm for 10 minutes. One ml aliquots were deproteinated with 0.25 ml 15% sulfosalicylic acid (GERRITSEN *et al.*(2), and centrifuged. The clear supernatant was removed and diluted to 5 ml with pH 2.2 citrate buffer. One ml was added directly to the columns with 0.25 u mole norleucine as an internal standard.

The procedures of JOHNSON and CARROLL(5) were used with slight modifications for the determination of sugars and of organic acids. Sorbital was used as a sugar internal standard, Dowex 21K, 50-100 mesh, washed with 2N sodium formate, as an anion exchange resin, and bis-(trimethylsilyl) trifluoroacetamide (BSTFA) (Aldrich Chemical Co., Inc.) as a silylation reagent. A Model DDS 160 Microtec Instrument (Tracor, Inc.) was used for gas chromatographic analyses.

RESULTS AND DISCUSSION

The average values for the chemical characteristics of the juice from the three different classes of cashew apples (Table I) are in general agreement with that which might be expected and with the results of other studies (PRUTHI *et al.*(9), HAENDLER and DUVERNEUIL(3), HOLANDA *et al.*(4), LOPES(6). The slightly higher amount of soluble solids and reducing sugars in the present studies are a result of choosing only very ripe apples for experimental material to eliminate differences caused by different stages of maturity seen by MAIA *et al.*(7).

The quality measured with the greatest variability in this experiment was the quantity of ascorbic acid. Values ranged between 195 to 325 mg/100

TABLE I

Average Values of Chemical Characteristics of Cashew Apple Juice. Fortaleza, Ceará, Brazil, 74.

	Sweet Juice	Sour Juice	Astringent Juice
ºBrix	15.2	13.2	12.8
pH	4.3	3.6	4.2
T. Acidity (% malic acid)	.48	1.30	.58
Protein (g/100 ml)	1.04	.74	.88
Ascorbic acid (mg/100 ml)	270	292	294
Tannins (g/100 ml)	.22	.28	.58
Reducing sugars (g/100 ml)	11.7	8.8	10.2

ml of juice and differences between classes were insignificant. These values were slightly lower than those found in Mozambique (LOPES(6).

The significantly higher values found for tannins in the samples of astringent juice approximated those values found by MAIA *et al.*(7) in unripe cashew apples.

Predominant free amino acids in cashew apple juice (Table 2) were found to be alanine, aspartic acid, glutamic acid, serine, threonine, and proline. In an earlier study, using paper chromatography, VENTURA and LIMA (19) found that glycine, valine, the leucines, and tryptophane were also prominent. We found tryptophane in only minimal amounts and found it to be absent from samples of acidic juice. Other amino acids present in only small quantities were methionine, cystine, and hystidine. In a study of the amino acids present in the whole cashew apple, HAENDLER and DUVERNEUIL(3) found valine, aspartic acid, threonine, lysine and alanine to be present in appreciable quantities, only traces of proline and serine, and found methionine to be absent.

The amount of each amino acid in cashew apple juice was significantly lower than that found in grape juice (STATDMAN(16) or in citrus juice (VANDERCOOK and PRICE(18). In addition, the total amount of free amino acids represents only one sixth of the Kjehdahl nitrogen present. The remainder is presumed to be proteins and other nitrogenous substances.

The mean of the total free amino acid content of the sweet juice, 0.17 mg/100 ml, significantly higher than that of the sour juice, 0.12 mg/100 ml, while the differences between the astringent juice, 0.15 mg/100 ml, and the previous two were insignificant. Since cashew apple juice is about 90% moisture, it has approximately 10% protein on a dry weight basis, but the quality of this protein is low because of the small amounts of several essential amino acids, especially methionine.

Sugar content of cashew apple juice is shown in Table 3. In determination of total glucose, the values calculated

TABLE 2

Free Amino Acid Content of Cashew Apple Juice (u mole/100 ml). Fortaleza, Ceará, Brasil, 74.

AMINO ACID	Sweet Juice	Sour Juice	Astringent Juice
Lysine	15	37	20
Histidine	13	16	10
Arginine	36	20	6
Aspartic acid	175	69	147
Threonine	102	38	32
Serine	131	83	110
Glutamic acid	185	91	190
Proline	109	67	59
Glycine	30	25	20
Alanine	312	362	251
Cystine	7	3	3
Valine	20	24	18
Methionine	1	1	1
Isoleucine	32	40	26
Leucine	70	95	57
Lyrosine	59	57	83
Phenylalanine	25	32	53
Tryptophane	3	—	11
Y-Aminobutric acid	N.C.[a]	N.C.[a]	N.C.[a]
Total free amino acids (g/100 ml)	.17	.12	.15

[a]N.C. = not calculated

for a-and B-glucose were added. The amount of glucose in the three juice classes was very constant, with the degree of sweetness being determined by variations in the amount of fructose present. HOLANDA *et al.*(4) found that non-reducing sugars comprised an insignificant part of the total sugars found in cashew apple juice; the present study indicates that sucrose is completely absent.

Preliminary experiments in this laboratory using paper chromatography indicated that malic acid was the only organic acid present in cashew apple juice; the present study (Table 4) shows that citric acid is also present in varying proportions. In the sweet juice, over 20% of the total organic acid content was comprised of citric acid, while in the sour juice it was present in quantities of less than 1%. A third acid having a relative retention time equal to that of quinic acid was observed also to be present in very small quantities.

CONCLUSIONS

Although much of Brazil's present supply of cashew comes from wild frees from seed propagation, governmental encouragement towards a large expansion of acreage is taking place. Recent research has shown the possibility of selection of desirable characteristics of both the apple and the nut through vegetative propagation (PARENTE(11). Data presented in this research will aid in the selection of parent trees to be used. It has shown that differences exist in the constituients of the three basic taste classes of cashew apple. In industrial processing, such as that in Northeast Brazil (MAIA *et al.*(7), the sweet and sour apple can be blended for optimum taste while the astringent apple can be used for products in which the tannins can be precipitated.

Although cashew apple juice is a poor source of quality protein, it is an excellent source of ascorbic acid and easily assimilated sugars. The tremendous quantities of raw material available warrant the increased processing of this product.

SUMÁRIO

Sucos obtidos de cajus dos tipos "vermelho" e "amarelo", classificados como doce, azedo e adstringente, foram analisados com auxílio de cromatografia (ion exchange), cromatografia gasosa (GLC) e por outros métodos para determinação de amino ácidos, açúcares, ácidos orgânicos, ácido ascórbico e tanino.

Diferenças significativas foram observadas, sendo a mais notável o aumento do nível de tanino nos cajus adstringentes e o decréscimo do nível de amino-ácidos livres nos cajus azedos. O ácido málico foi o ácido orgânico

TABLE 3

Sugar Content of Cashew Apple Juice (g/100 ml). Fortaleza, Ceará, Brazil, 1974.

SUGAR	Sweet Juice	Sour Juice	Astringent Juice
Fructose	3.9	2.3	3.4
Total glucose	7.0	7.3	7.2
Total sugars	10.9	9.6	10.6

TABLE 4

Organic Acid Content of Cashew Apple Juice (g/100 ml). Fortaleza, Ceará, Brazil, 1974.

ORGANIC ACID	Sweet Juice	Sour Juice	Astringent Juice
Malic	.36	12.8	.49
Citric	.10	.01	.03

predominante, aparecendo pequenas quantidades de outros ácidos orgânicos.

O conteúdo de ácido ascórbico variou de 195-325 mg/100 ml.

A comercialização do pedúnculo dos diversos tipos de caju deve ser estimulada, tendo em vista o valor de seus nutrientes.

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