Journal of Food Resource Science

ISSN 2224-3550

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Food Resource Science 1 (2): 32-36, 2012
ISSN 2224-3550 / DOI: 10.3923/.jfrs.2012.32.36

Minerals and Bioactive Compounds in Cashew Apple (*Anacardium occidentale* L.)

R. Bhakyaraj and K. Singaravadive
Department of Food Microbiology, Indian Institute of Crop Processing Technology, Ministry of Food Processing Industries, Government of India, Thanjavur-613 005, Tamil Nadu, India

Corresponding Author: K. Singaravadive, Department of Food Microbiology, Indian Institute of Crop Processing Technology, Ministry of Food Processing Industries, Government of India, Thanjavur-613 005, Tamil Nadu, India

ABSTRACT

The cashew apple is a tropical fruit, which is being wasted as manure after picking the nut attached in it. Understanding the presence of bioactive compounds and minerals in pseudo fruit will help in developing technologies for value addition of cashew apple. In the present study variation in minerals and bioactive compounds of cashew apple juice was investigated. Minerals like Calcium (Ca), magnesium (Mg), copper (Cu), potassium (K), phosphorous (P), iron (Fe), sodium (Na), zinc (Zn) and selenium (Se) were analyzed by ICP-OES (inductively coupled plasma optical emission spectrophotometer) and bioactive compounds by GC-MS. The results showed that cashew apple is rich in minerals especially potassium (3337 ppm), phosphorous (440.2 ppm) and followed by magnesium (279.3 ppm). Other minerals like Iron, sodium, zinc and calcium also present in significant level. The bioactive compounds like 9,12-octadecadienoic acid (Z,Z)- and 9,12-octadecadienoyl chloride (Z,Z)- etc were also present in cashew apple. The results ensured that the biowaste cashew apple is a good source of various essential minerals and bioactive compounds which can be used to develop nutritious value added food and beverages.

Key words: Biowaste utilization, micronutrients, value addition, beverages, value added food

INTRODUCTION

The cashew tree (*Anacardium occidentale* L.) is a tropical tree native of Brazil and is being extensively grown in India, East Africa and Vietnam (Muniz *et al*., 2006). A main product from cashew tree is cashew nut (true fruit), which is rich in fat and protein. After picking the nut from the peduncle (cashew apple-pseudo fruit) (Garruti *et al*., 2006) cashew apple become biowaste. Cashew apple is used as a remedy for chronic dysentery and for sore throat in Cuba and in Brazil (Morton, 1987). Most of the fruit by-products could be used as functional ingredients when designing health foods (functional foods), especially non-digestible carbohydrates (dietary fiber) and bioactive compounds (ascorbic acid and flavonoids) (Laufenberg *et al*., 2003). Cashew apples are available in India in huge quantities but they find little commercial application at present except the manufacture of fenny (a type of brandy) and pectin (Maini and Anand, 1993; Ward and Ray, 2006).

Cashew apple juice is rich in sugars (Azevedo and Rodrigues, 2000), antioxidants (Trevisan *et al*., 2006; Kubo *et al*., 2006) and vitamin C (Azevedo and Rodrigues, 2000) and is widely consumed in Brazil (Nagaraja, 2007). Cashew apple juice has the potential to be a natural

source of vitamin C and sugar in processed foods (De Carvalho *et al*., 2007). Cashew nut has a fine taste and a market potential but cashew apple even though rich in nutritive values like vitamin C and minerals, i.e., Ca, P, Fe it is not accepted as food because it contains high tannin content and astringent taste however, the bioactive compounds, vitamins and minerals present in it, should be explored for other value addition.

The cashew apple color varied from bright red, orange, or yellow with a soft and fibrous fleshy. As variations in minerals and other nutrient content of apples are observed, in the present study, cashew apple available in southern part of India are analyzed for minerals and bioactive compounds.

MATERIALS AND METHODS

Collection of cashew apples: The undamaged and fully ripened cashew apples were collected from the Ghandarvakottai, Pudukottai District, Tamil Nadu India in November, 2011. The apples were brought as fresh to the Food Microbiology Laboratory of Indian Institute of crop processing technology, Thanjavur, Tamil Nadu and immediately processed.

Extraction of fruit juice: Cashew apple juice was extracted from selected cashew apples by Fruit Juice Extractor (GaganUdyog, Jalandhar-4, India) available at Incubation Centre, IICPT, Thanjavur, Tamil Nadu, India.

Minerals analysis using ICP-OES: For analysis of minerals 100 mL of the fruit juice was ashed using Muffle furnace for 4 h and it was cooled for 30 mts. After cooling the ash was dissolved with 20 mL of 1:1 ratio HCl:distilled water. The volume of the solution was reduced to 5-8 mL by evaporating in water bath and it was made up to 50 mL. The sample was used for determination of minerals using inductively Coupled Plasma Optical Emission Spectrophotometer (PerkinElmer). Cashew apple juice was extracted with chloroform and that extract was analyzed using GC-MS for different bioactive components.

RESULTS AND DISCUSSION

The cashew apple juice was found to contain a total of nine minerals in different level. Minerals like magnesium, sodium, iron, calcium, copper, sodium and zinc were also present at significant level of 279.70, 204, 133.9, 80.42, 1.17, 204.0 and 16.48 ppm, respectively in cashew apple juice (Table 1). Among the various minerals potassium was observed in high level (3337 ppm) followed by phosphorous (440.20 ppm). Potassium (K) is very essential element to prevent bone

Table 1: Mineral content in cashew apple juice

Name of the minerals	Quantity of mineral (ppm)
Ca	80.42
Cu	01.17
Fe	133.90
K	3337.00
Mg	279.70
Na	204.00
P	440.20
Zn	16.48
Se	0.024

demineralization which is by controlling of calcium loss in urine (Tucker *et al.*, 1999; He and MacGregor, 2001). Nagaraja (2009) also reported that some varieties of cashew apple are rich in potassium.

Copper is an essential and beneficial element in human metabolism and the average daily dietary requirement for copper in the adult human has been estimated as 2 mg and for infants and children at 0.05 mg kg^{-1} b.wt. (Browning, 1969; WHO, 2004). The NRC (1980) reported that safe and adequate daily dietary intakes of copper ranging from 0.5-0.7 mg day^{-1} for infants of 6 months age or less up to 2-3 mg day^{-1} for adults. The copper content of 1.07 ppm observed in the cashew apple juice is within the safe prescribed limits of infants.

Sodium is the principle extracellular cation and is used for osmoregulation in inter modular fluid of human body. The recommended daily allowance of sodium is 115-75000 ppm for infants, 324-975 mg kg^{-1} for children and 1100-3300 ppm for adults (Crook, 2006). Enzymes are involved in macronutrient metabolism and cell replications are mainly Zn dependent (Hays and Swenson, 1985; Arinola, 2008). Zinc is widely distributed in plant and animal tissues and present in all living cells. In cashew apple juice 16.48 ppm of Zinc was observed.

Magnesium is an active element in several enzyme systems in which thymine pyrophosphate is a cofactor. Oxidative phosphorylation is greatly reduced in the absence of magnesium. It also activates pyruvic acid carboxylase, pyruvic acid oxidase and the condensing enzyme for the reactions in the citric acid cycle (Murray *et al.*, 2000). Even though the value obtained in the cashew apple juice is low as compared to the standard value, it can be used as natural sources of minerals with other food and beverages to rectify the child malnutrition.

Activity of phytocomponents identified in chloroform extract of cashew apple by GC-MS: The studies on the active principles in the chloroform extract of cashew apple by GC-MS analysis clearly showed the presence of twelve compounds (Table 2). The compounds were identified as 9,12-octadecadienoic acid (Z,Z)-15-hydroxy-pentadecanoic acid, 15-hydroxy-pentadecanoic acid and 9,12-octadecadienoyl chloride (Z,Z)- etc. Among the various compounds 9,12-octadecadienoic acid (Z,Z)- was found to be the highest peak area (50.16%) followed by 9,12-octadecadienoyl chloride (Z,Z)- (21.35%) and 15-hydroxy-pentadecanoic acid (16.32%). Unsaturated fatty acids exist in the cashew apple extract, especially polyunsaturated fatty acids have a wide range of biological functions, especially 9,12-octadecadienoic acid which belongs to the family of n-6 polyunsaturated

Table 2: Bioactive compounds identified in the chloroform extract of the cashew apple by GC-MS

Retention time (min)	Name of the compound	Molecular formula	Molecular weight	Peak area (%)
9.21	4-Tetradecene (Z)-	$C_{14}H_{28}$	196	0.01
11.14	1-Octadecyne	$C_{18}H_{34}$	250	0.02
11.45	1,10-Decanediol	$C_{10}H_{22}O_2$	174	0.03
16.79	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280	50.16
18.07	15-Hydroxy-pentadecanoic acid	$C_{15}H_{30}O_3$	258	16.32
20.66	9,12-Octadecadienoyl chloride (Z,Z)-	$C_{18}H_{31}ClO$	298	21.35
21.01	Stearic anhydride	$C_{36}H_{70}O_3$	550	3.46
23.73	9,12-Octadecadienoic acid (Z,Z)-, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{21}H_{38}O_4$	354	2.28
27.18	E,E-1,9,17-Docasatriene	$C_{22}H_{40}$	304	1.04
33.60	7,11-Hexadecadienal	$C_{16}H_{28}O$	236	4.28
34.78	1,2-15,16-Diepoxyhexadecane	$C_{16}H_{30}O_2$	254	0.89

fatty acids and (Z, Z, Z)-9,12,15-octadecatrienoic acid which belongs to n-3 family of polyunsaturated fatty acids (Zhang *et al*., 2006), plays an important role in human and animal body.

In many cases, the two families of polyunsaturated fatty acids in the functional constraints on the co-ordination, co regulating organism's life activity, include lipid metabolism, cardiovascular function regulation, blood glucose concentration regulation, cell regulation, immune regulation and other aspects. Among the various components 9,12-octadecadienoic acid (Z, Z)- is found to be the maximum peak area in cashew apple juice (50.16%). The results presented herein are in agreement with those presented by Garruti *et al*. (2003) who evaluated volatile substances consisting of esters and aldehydes in cashew apple. Like that of our present study chemical composition of the cashew apple has been the subject of investigation by number of authors (Kubo *et al*., 2006).

CONCLUSION

The cashew apple shows varying quantity of minerals and among them potassium is found to be highest amount of 3337.0 ppm followed by phosphorous, magnesium and sodium. Among the bioactive compounds found in extract of cashew apple 9,12-octadecadienoic acid (Z,Z)- is found to be higher quantity. Hence the biowaste of cashew apple can be act as source of antioxidant and mineral supplement in food as allied product development.

ACKNOWLEDGMENT

The authors very much thank Dr. K. Alagusundaram, Director, Indian Institute of Crop Processing Technology, Thanjavur for providing all the facilities and support to carry out the work.

REFERENCES

Arinola, O.G., 2008. Essential trace elements and metal binding proteins in Nigerian consumers of alcoholic beverages. Pak. J. Nutr., 7: 763-765.

Azevedo, D.C.S. and A. Rodrigues, 2000. Obtainment of high-fructose solutions from cashew (*Anacardium occidentale*) apple juice bysimulated moving-bed chromatography. Sep. Sci. Technol., 35: 2561-2581.

Browning, E., 1969. Toxicity of Industrial Metals. 2nd Edn., Butterworths, London, Pages: 391.

Crook, M.A., 2006. Clinical Chemistry and Metabolic Medicine. 7th Edn., Hodder Arnold, London, ISBN-13:978 0 340 90618 7.

De Carvalho, J.M., G.A. Maia, R.W. de Figueiredo, E.S. de Brito, S. Rodrigues, 2007. Development of a blended nonalcoholicbeverage composed of coconut water and cashew apple juice containing caffeine. J. Food Qual., 30: 664-681.

Garruti, D.S., M.R.B. Franco, M.A.A.P. Silva, N.S. Janzantti and G.L. Alves, 2003. Evaluation of volatile flavor compounds from cashew apple (*Anacardium occidentale* L) juice by the Osme gas chromatography/olfactometry technique. J. Sci. Food Agric., 83: 1455-1462.

Garruti, D.S., M.R.B. Franco, M.A.A.P. da Silva, N.S. Janzantti and G.L. Alves, 2006. Assessment of arom aimpact compounds in a cashew apple-based alcoholic beverage by GC-MS and GC-olfactometry. LWT-Food Sci. Technol., 39: 373-378.

Hays, V.W. and M.J. Swenson, 1985. Minerals and Bones. In: Dukes? Physiology of Domestic Animals, Dukes, H.H. and M.J. Swenson (Eds.). 10th Edn. Cornell University Press, Ithaca, NY., USA., pp: 449-466.

He, F.J. and G.A. MacGregor, 2001. Beneficial effects of potassium. Br. Med. J., 323: 497-501.

Kubo, I., N. Masuoka, T.J. Ha and K. Tsujimoto, 2006. Antioxidant activity of anacardic acids. Food Chem., 99: 555-562.

Laufenberg, G., B. Kunz and M. Nystroem, 2003. Transformation of vegetable waste into value added products: (A) the upgrading concept; (B) practical implementations. Bioresour. Technol., 87: 167-198.

Maini, S.B. and J.C. Anand, 1993. Utilization of Fruit Wastes. In: Advances in Horticulture, Vol. 4, Chadha, K.L. and O.P. Pareek (Eds.). Malhotra Publishing House, New Delhi, India, pp: 1967-1992.

Morton, J., 1987. Cashew Apple. In: Fruits of Warm Climates, Miami, F.L. (Ed.). E.C.H.O. Inc., Myers, FL., pp: 239-240.

Muniz, C.R., M.D.F. Borges and F.D.C.O. Freire, 2006. Tropical and Subtropical Fruit Fermented Beverages. In: Microbial Biotechnology in Horticulture, Ray, R.C and O.P. Ward (Eds.). Vol. 2. Science Publishers, Enfield, NH., USA.

Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Radwell, 2000. Harper's Biochemistry. 25th Edn., McGraw Hill Health Profession Division, USA.

NRC, 1980. Copper: Recommended Dietary Allowances. Food and Nutrition Board, National Research Council (NRC) and National Academy of Sciences (NAS). 9th Edn., National Academy Press, Washington, DC., pp: 151-154.

Nagaraja, K.V., 2007. Biochemistry of cashew (*Anacardium occidentale* L.): A review. J. Food Sci. Technol., 44: 1-9.

Nagaraja, K.V., 2009. Studies on mineral composition of cashew. Indian J. Hortic., 66: 101-108.

Trevisan, M.T.S., B. Pfundstein, R. Haubner, G. Wurtele, B. Spiegelhalder and H. Bartsch, 2006. Characterization of alkyl phenols in cashew (*Anacardium occidentale*) products and assay of their antioxidant capacity. Food Chem. Toxicol., 44: 188-197.

Tucker, K.L., M.T. Hannan, H. Chen, L.A. Cupples, P.W. Wilson and D.P. Kiel, 1999. Potassium, magnesium and fruit and vegetable intakes are associated with greater bone mineral density in elderly men and women. Am. J. Clin. Nutr., 69: 727-736.

WHO, 2004. Guidelines for Drinking Water Quality. 3rd Edn., Recommendation, Geneva, Pages: 515.

Ward O.P. and R.C. Ray, 2006. Microbial Biotechnology in Horticulture-An Overview. In: Microbial Biotechnology in Horticulture, Vol. 1, Ray, R.C. and O.P. Ward (Eds.). Science Publishers, Enfield, Greater London.

Zhang, H.T., L. Shan and Y.P. Bi, 2006. The functional relationship in of human and animal body between n-6 pufas and n-3 pufas. Shandong Agric. Sci., 38: 115-120.