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Investigation of Cashew Apple Juice Constituents Through GC-MS Analysis

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Abstract

Cashew apple is a tropical fruit widely known for its rich phytochemical composition and traditional medicinal uses. This study aimed to analyze the bioactive compounds present in cashew apple juice using Gas Chromatography-Mass Spectrometry (GC-MS). The ethyl acetate extract of cashew apple juice revealed 46 bioactive constituents, including esters, alcohols, aldehydes, fatty acids, organic acids, siloxanes and flavonoids. The most abundant compounds were 3-Hydroxyflavone (12.21%), Carbonic acid, tetradecyl vinyl ester (7.86%), Tricosane (4.12%), 9-Octadecene (3.99%) and Benzamide (5.71%), which possess antioxidant, antimicrobial, anticancer, anti-inflammatory and antimutagenic properties. Other significant compounds, such as Phenol, 3,5-bis(1,1-dimethylethyl)- (2.64%), 4,6-di-tert-Butylresorcinol (3.05%) and Sulfurous acid, octadecyl 2-propyl ester (3.36%), enhance the juice's pharmacological potential. Additionally, the presence of esters, aldehydes and terpenes contributes to the aromatic and organoleptic characteristics, making the juice nutritionally valuable. The GC-MS analysis proved to be a powerful technique for identifying phytoconstituents, facilitating their potential utilization in pharmaceuticals, nutraceuticals, cosmetics and functional foods. The diverse bioactivities of these compounds suggest promising applications in the prevention and treatment of chronic diseases, emphasizing the need for further pharmacological and nutritional research. Future studies should focus on isolating and characterizing these compounds to explore their therapeutic efficacy.

Keywords: *Anacardium Occidentale, Bioactive Compound, Cashew, Gas Chromatography-Mass Spectrum.*

Introduction

Numerous cultures use plants for medicinal purposes and these botanical sources provide pharmaceutical companies with specific bioactive compounds essential for developing effective drugs. The availability of natural chemical constituents makes plants a crucial resource in the pharmaceutical industry [1]. Plants are great natural antioxidants, hence phytochemical studies on extracts containing

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their primary phytocompounds are crucial. Component analysis of bioactive phytochemicals derived from plants is preceded by an essential extraction process that plays a critical role in their acquisition and isolation [2]. Medicinal plants are significant sources for medicines, constituting about 25% of prescriptions in the pharmaceutical industry.

The chemicals in a plant sample are detected and determined using a combined analytical method known as gas chromatography-mass spectroscopy (GC-MS). Determining the proportion of particular active compounds found in herbs that are used in culinary, cosmetic, medical, environmental and forensic applications may prove to be an intriguing tool [3]. GC-MS is essential for the phytochemical analysis and chemotaxonomic study of medicinal plants containing physiologically active compounds. The gas chromatography mass spectrometry technique, is among the fastest, most reliable and effective methods for identifying various bioactive substances. These include alcohols, alkaloids, long chain hydrocarbons, esters, acids, steroids and compounds containing nitro and amino acids. The integration of specific detection methods with GC-MS has transformed these instruments into sophisticated tools for evaluating a wide array of substances [4, 5]. As stated by the World Health Organization, more than 80% of individuals in developing countries use traditional medicine, which will remain significant in the healthcare system.

In northeastern Brazil, the cashew tree is referred to as a cajueiro and the fruit is known as caju, which comes from the Indigenous term acaju or acajous, which means “to pucker the mouth” and refers to the astringent flavor of the fruit [6]. Portuguese traders brought the cashew plant to eastern Africa and India in the late 16th century, where it thrived on nutrient poor sandy soils and was used as a fast growing soil maintainer near the coast. [7]. After becoming a part of the environment, cashew trees were especially exceedingly resistant and drought tolerant, surviving for 30-40 years in the high tropical heat of these regions [8]. The low growing, gnarled branches of cashew trees can spread and grow into huge forests in the tropical lowlands of the West Indies, Central America and northern South America [9]. Because of its high value, the cashew tree is extremely important [10, 11].

Numerous biological properties, including antimicrobial, antioxidant, anticancer [12] and antimutagenic [13, 14] properties, have been reported for cashew apple. The cashew apple has tremendous economic and medical value. In ethnopharmacology, this species is mostly used to treat infectious and inflammatory disorders, as well as pain ailments, such as diarrhea, psoriasis, stomatitis, aphthae, bronchitis, intestinal cramps, stomach discomfort, diabetes, muscle weakness and toothache [15, 16]. In this present study, the bioactive compounds of *Anacardium occidentale* juice were examined.

Materials and Methods

Cashew Apple Collection and Juice Preparation

Fresh cashew apples were gathered during the harvesting period (April-June 2023) and rinsed with sterile water. Cashew apple was immediately placed in plastic boxes. The fruits were macerated in a mixer grinder without the use of water. The pulp was filtered a muslin cloth and clarified using 0.3 gelatin to eliminate the tannin content. After full extraction, the clear solution was kept at -20° C until further examination [17]. **Figure 1** shows the procedure for Cashew Apple collection, extraction and GCMS analysis.

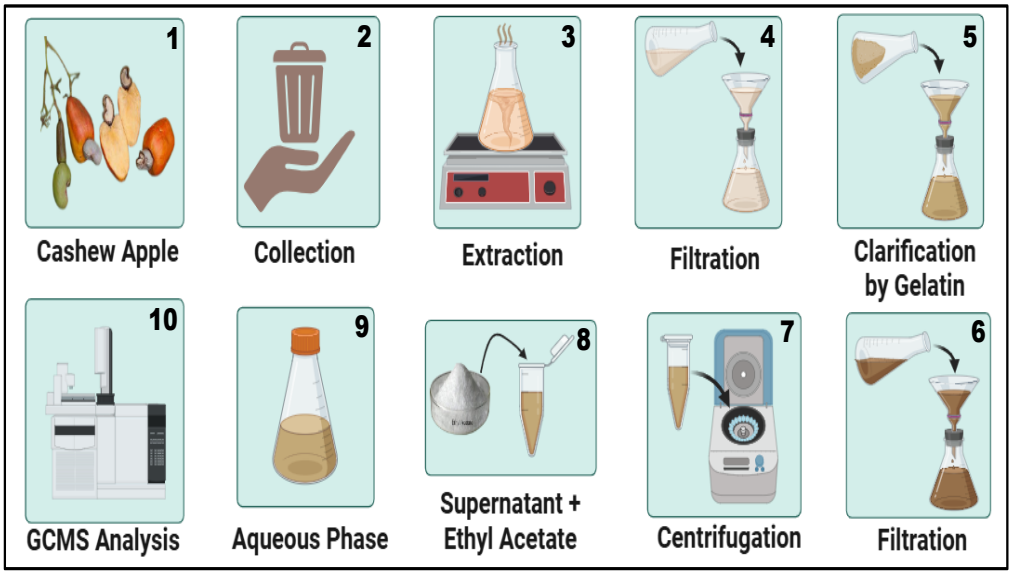


Figure 1. Stepwise Procedure for Cashew Apple Collection, Extraction and GC-MS Analysis

Analysis of Bioactive Substances in Cashew Apple Juice using GC-MS

The centrifugation of cashew apple juice was conducted at 10,000 rpm for 15-20 mins. The resulting supernatant was then transferred to a new microcentrifuge tube with care. A 2 mL aliquot of ethyl acetate was incorporated into the supernatant and the resultant mixture was vigorously mixed before being allowed to separate at room temperature. The following separation, the aqueous phase was then extracted from the ethyl acetate layer. The extract thus obtained underwent GC-MS analysis to identify and characterize the unique bioactive compounds present in the sample [18].

A Shimadzu 2010 plus instrument, equipped with an AOC-20i autosampler and a gas chromatograph linked to a mass spectrometer, was used for the GC-MS analysis of the ethyl acetate extract from cashew apple juice. An RTX 5Ms column (0.32 mm diameter, 30 m length, 0.50 µm thickness) was used in the electron impact mode at 70 eV. The carrier gas, helium (99%), was delivered at a steady rate of 1.00 mL/min. Sample injection was conducted in split mode at a 30:1 ratio. The ion source temperature was established at 200 ºC, the oven at 50 ºC and the injector at 250 ºC. The mass spectra of particles between 40 and 450 Da were acquired at 70 eV with a scan interval of 0.5 s. The overall duration of the GC runs was 27.00 mins. The relative percentage of each component was determined by dividing the average peak area by the total area. The Turbo Mass Ver 5.2.0 software was used to manage the mass spectra and chromatograms.

Identification of Components

The analysis of the GC-MS data was analyzed using the National Institute of Standards and Technology (NIST) database, which contains over 62,000 spectral patterns. The spectra of the unidentified components were meticulously compared to those known components listed in the NIST collection. The components in the test materials were identified based on their nomenclature, molecular weights and structural features [19].

Results

Therapeutic plants serve as a rich source of novel pharmaceuticals, with numerous contemporary drugs derived indirectly from their constituents. These botanical resources have supplied a range of components that are crucial for treating various illnesses and health conditions. The examination and isolation of plant materials are fundamental to the advancement, enhancement and quality

assurance of herbal preparations. Furthermore, investigations into medicinal plants enhance our knowledge of plant-based toxins, thereby protecting both human and animal populations against naturally occurring harmful substances. Hence, this study focused on identifying the bioactive compounds present in the ethyl acetate extract of cashew apple juice through GC-MS analysis.

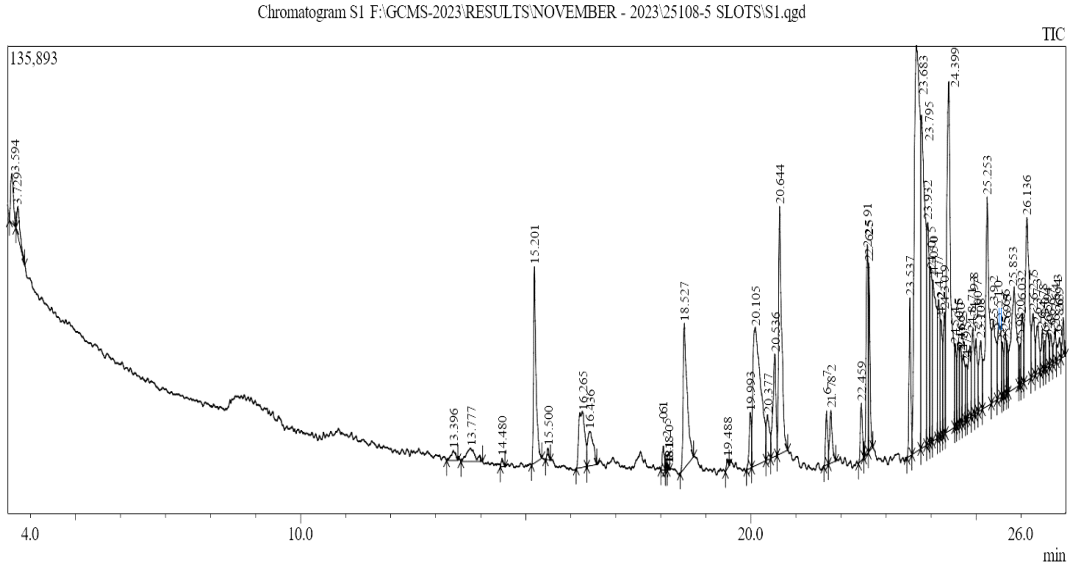
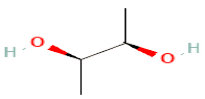
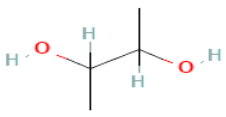
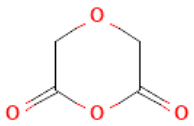
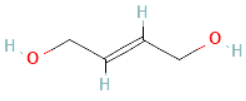
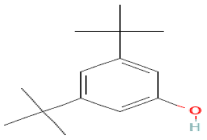
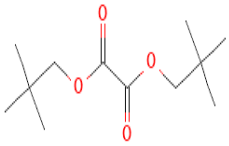
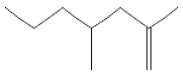
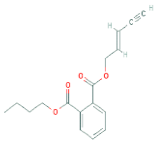
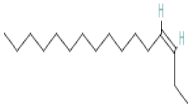
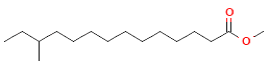
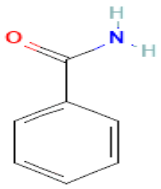


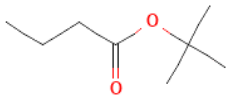
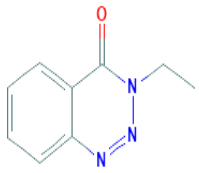
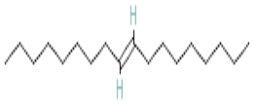
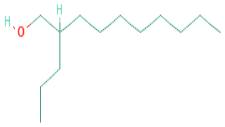
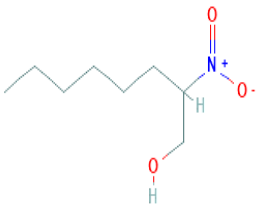
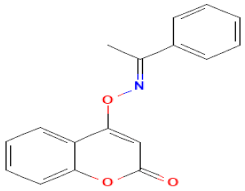
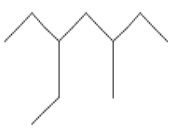
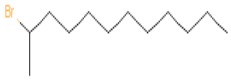
Figure 2. CAJY-P - Cashew Apple Juice Yellow Panruti Ethyl Acetate Extract's GC-MS Spectrum

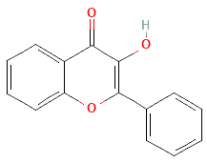
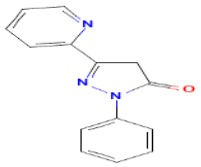
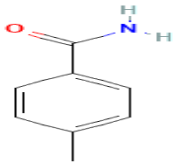
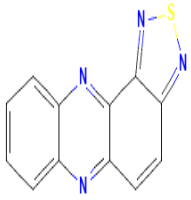
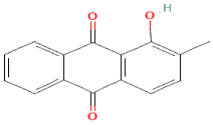
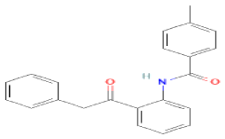
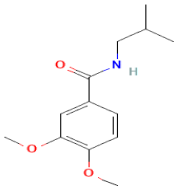
The chemical compositions of isolates secondary metabolites were identified and the separated chromatograph were compared using the NIST library. The Cashew apple juice yellow Panruti (CAJY-P) ethyl acetate GC-MS chromatogram showed 46 compounds with different peak areas and retention times. All compounds have been documented, including their molecular formulas, molecular weights, peaks area and retention times. The corresponding 3D structures are presented in **Table 1** and **Figure 2**.

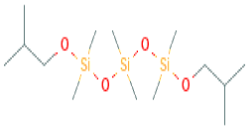
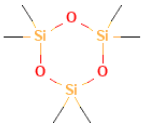
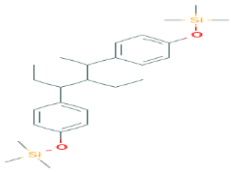
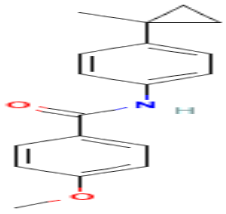
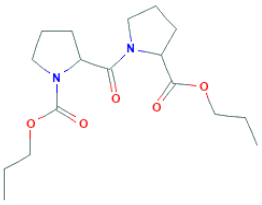
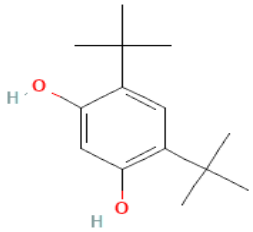
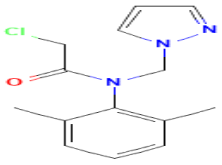
Table 1. Chemical Compositions of CAJY-P Ethyl Acetate Extract Analysis by GC-MS

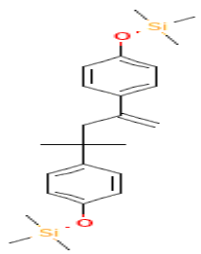
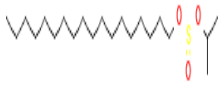
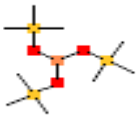
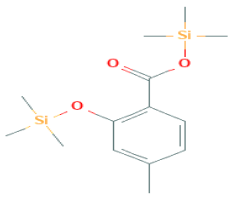
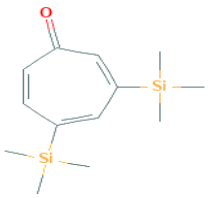
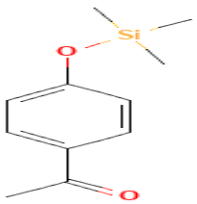
Peak	Name	R. Time	Area%	Molecular formula	Molecular formula	Molecular weight (g/mol)	Biological activity
1.	2,3-Butanediol, [R-(R*,R*)]-	3.594	0.74	C4H10O2		90.12	Antimicrobial activity
2.	2,3-BUTANEDIOL	3.729	0.47	C4H10O2		90.12	Antimicrobial activity
3.	1,4-Dioxane-2,6-dione	13.396	0.24	C4H4O4		116.07	Antimicrobial Activity, Antioxidant Activity
4.	2-BUTENE-1,4-DIOL	13.777	0.58	C4H8O2		88.11	Antimutagenic Activity

5.	CYCLOPROPANE	14.480	0.09	C3H6		42.08	Antimicrobial Activity, Anticancer Activity
6.	Phenol, 3,5-bis(1,1-dimethylethyl)-	15.201	2.64	C14H22O		206.32	Antioxidant, antimicrobial activity.
7.	Oxalic acid, dineopentyl ester	15.500	0.12	C12H22O4		230.30	Antimicrobial Activity, Antimutagenic Activity, Anti-inflammatory Activity
8.	2,4-DIMETHYL-1-HEPTENE	16.265	1.81	C9H18		126.24	Antimicrobial, antioxidant activity.
9.	Phthalic acid, butyl pent-2-en-4-yn-1-yl ester	16.436	1.00	C17H18O4		286.32	Antimicrobial, antioxidant activity
10.	DOCOSANE	18.061	0.25	C22H46		310.6	Antimicrobial Activity
11.	Trifluoroethanol, TBDMS derivative	18.125	0.04	C8H17F3OSi		214.30	Antimicrobial Activity
12.	3-HEXADECENE, (Z)-	18.527	3.06	C16H32		224.42	Antimicrobial, antioxidant activity, Anti-inflammatory Activity
13.	TETRADECANOIC ACID, 12-METHYL-, METHYL ESTER	19.993	0.68	C16H32O2		256.42	Antimicrobial activity
14.	Benzamide	20.105	5.71	C7H7NO		121.14	Anticancer, anti-inflammatory activity

15.	BUTANOIC ACID, 1,1-DIMETHYLETHYL ESTER	20.377	0.76	C8H16O2		144.21	Antimicrobial Activity, Anti-inflammatory Activity
16.	1,2,3-BENZOTRIAZIN-4(3H)-ONE, 3-ETHYL-	20.536	1.61	C9H9N3O		175.19	Anticancer and antimicrobial properties.
17.	9-OCTADECENE, (E)-	20.644	3.99	C18H36		252.5	Antimicrobial Activity, Antioxidant Activity
18.	2-PROPYLDECAN-1-OL	21.687	0.56	C13H28O		200.36	Antimicrobial activity
19.	1-Octanol, 2-nitro-	21.782	0.74	C8H17NO3		175.23	Antimicrobial Activity, Antioxidant Activity, Antimutagenic Activity, Anti-inflammatory Activity
20.	4-(([(E)-1-PHENYLETHYLIDENE] AMINO) OXY)-2H-CHROMEN-2-ONE	22.459	0.60	C17H13NO3		279.29	Anticancer and anti-inflammatory activity
21.	Formic acid, undecyl ester	22.591	2.20	C12H24O2		200.32	Antimicrobial activity
22.	HEPTANE, 3-ETHYL-5-METHYL-	22.625	1.49	C10H22		142.28	Antimicrobial Activity
23.	2-Bromo dodecane	23.537	1.56	C12H25Br		249.23	Antimicrobial activity

24.	3-Hydroxyflavone	23.683	12.21	C15H10O3		238.24	Antioxidant, anticancer and anti-inflammatory activity
25.	1-Phenyl-3-(2-pyridyl)-5-pyrazolone	23.932	2.91	C14H11N3O		237.26	Anti-inflammatory and analgesic properties.
26.	Benzamide, 4-methyl-	24.005	1.93	C8H9NO		135.16	Anticancer activity
27.	2-Thia-1,3,6,11-tetraaza-cyclopenta[a]antracene	24.050	3.40	C12H6N4S		238.27	Anticancer and antimicrobial properties.
28.	1-Hydroxy-2-methylanthraquinone	24.230	1.22	C15H10O3		238.24	Antioxidant and antimicrobial properties
29.	Carbonic acid, tetradecyl vinyl ester	24.399	7.86	C17H32O3		284.4	Antioxidant and antimicrobial properties, Anti-inflammatory Activity
30.	4-METHYL-N-[2-(PHENYLACETYL)PHENYL] BENZAMIDE	24.660	0.88	C22H19NO2		329.4	Anticancer and anti-inflammatory activity.
31.	Benzamide, 3,4-dimethoxy-N-isobutyl-	24.795	0.50	C13H19NO3		237.29	Anti-inflammatory properties.

32.	1,1,3,3,5,5-Hexamethyl-1,5-bis(2-methylpropoxy) trisiloxane	24.938	1.14	C14H36O4Si3		352.69	Antimicrobial Activity, Anti-inflammatory Activity
33.	CYCLOTRISILOXANE, HEXAMETHYL-	25.108	1.07	C6H18O3Si3		222.46	Antimicrobial Activity
34.	TRICOSANE	25.253	4.12	C23H48		324.6	Antimicrobial Activity
35.	Benzestrol, 2TMS derivative	25.510	1.37	C26H42O2Si2		442.8	Antimicrobial Activity, Antioxidant Activity
36.	Benzamide,4-methoxy-N-[4-(1-methylcyclopropyl) phenyl]-	25.595	0.50	C18H19NO2		281.3	Antimicrobial Activity, Anticancer Activity, Anti-inflammatory Activity
37.	d-Prolyl-d-proline, n-propoxycarbonyl-, propyl ester	25.695	0.44	C17H28N2O5		340.4	Antioxidant Activity
38.	4,6-di-tert-Butylresorcinol	25.853	3.05	C14H22O2		222.32	Antimicrobial Activity, Antioxidant Activity, Antimutagenic Activity, Anticancer Activity, Anti-inflammatory Activity
39.	METAZACHLOR	25.980	0.32	C14H16ClN3O		277.75	Antimicrobial Activity

40.	4-Methyl-2,4-bis(p-hydroxyphenyl) pent-1-ene, 2TMS derivative	26.032	0.84	C24H36O2Si2		412.7	Antimicrobial Activity, Antioxidant Activity, Anti-inflammatory Activity
41.	Sulfurous acid, octadecyl 2-propyl ester	26.136	3.36	C21H44O3S		376.6	Antimicrobial Activity, Anti-inflammatory Activity
42.	ARSENOUS ACID, TRIS(TRIMETHYLSILYL) ESTER	26.275	0.97	C9H27AsO3Si3		342.49	Antimicrobial Activity,
43.	Benzoic acid, 4-methyl-2-trimethylsilyloxy-, trimethylsilyl ester	26.373	0.80	C14H24O3Si2		296.51	Antimicrobial Activity, Antioxidant Activity
44.	2,4,6-Cycloheptatrien-1-one, 3,5-bis-trimethylsilyl-	26.530	0.23	C13H22OSi2		250.48	Antioxidant Activity
45.	ACETOPHENONE, 4'-(TRIMETHYLSILOXY)-	26.667	0.37	C11H16O2Si		208.33	Antimicrobial Activity, Anticancer Activity, Anti-inflammatory Activity
46.	Penta siloxane, dodecamethyl-	26.863	0.33	C12H36O4Si5		384.84	Anti-inflammatory Activity

The GC-MS analysis of the ethyl acetate extract obtained from cashew apple juice identified a major bioactive compound at 12.21 %. The major bioactive compounds present in the samples were 3-Hydroxyflavone (12.21%), Carbonic acid, tetradecyl vinyl ester (7.86%), Tricosane (4.12%) and 9-octadecene, (E) (3.99%). In the isolation experiments, further attention was paid to compounds with larger

peak area. The amount of a component in the combination is correlated with the peak area.

Discussion

The GC-MS analysis of cashew apple juice provided valuable insights into its complex chemical composition, revealing various bioactive compounds. This study identified several key compounds that contribute to the nutritional and aromatic profile of juice, including organic acids, esters, alcohols, aldehydes and fatty acids. These compounds play crucial roles in the flavor, aroma and potential health benefits of cashew apple juice.

In this study, the CAJY-P ethyl acetate GC-MS chromatogram revealed 49 compounds with different peak areas and retention times. In similar studies, Sivagurunathan *et al.,* analyzed the GC-MS analysis of successive extracts such as chloroform and NaOH extracts of cashew apple. The results revealed multiple phenolic compounds. Sample 1 (S1) showed 8 compounds likewise sample 2 showed 7 compounds, sample 3 showed 5 compounds and sample 4 showed 7 compounds [20].

According to Oloniya *et al.,* the GC-MS chromatograms of samples A (undefatted cashew kernel flour), B (cold pressed defatted cashew kernel flour) and C (hot pressed defatted cashew kernel flour) were examined. Sample A (undefeated cashew kernel flour) contained 42 bioactive compounds, hot-pressed defatted cashew kernel flour contained 36 bioactive compounds and hot pressed cashew kernel flour contained 33 bioactive compounds, according to GC-MS [21].

An ethanol extract of *A. occidentale* was subjected to GC-MS analysis by Ghosh *et al.,* two compounds, methyl ester and 14,17-octadecadienoic acid, can heal wounds and cause skin scaling. GC-MS analysis confirmed the antioxidant, anti-inflammatory, antifibrotic and vasodilatory qualities of hexadecanoic acid,16 methyl ester [22].

Using high resolution gas chromatography, 41 compounds were identified in the cashew apple juice sample. Esters comprise majority of volatile substances in cashew apple beverages, followed by alcohols, acids and aldehydes. Some ethyl esters, such as ethyl decanoate, ethyl lactate, ethyl hexanoate, ethyl butyrate and ethyl 3-methyl butyrate are the main constituents [23].

Priyadharshini *et al.,* investigated the active principles present in the methanolic extract of A. occidentale L. through GC-MS analysis. The analysis of the methanolic extract of the CA juice revealed the presence of 11 bioactive phytocomponents. The results indicated the identification of the following compounds: 2,3-dihydroxy propyl ester, trans-13-octadecenoic acid and 9-octadecenoic acid (Z)-methyl ester [18].

This study presents a novel approach by employing advanced GC-MS analysis to identify a broader range of bioactive compounds in cashew apple juice. Unlike previous studies that focused on specific extracts or a limited number of compounds, this research identified 46 bioactive compounds in a single extraction process. Key compounds such as 3-Hydroxyflavone, Carbonic acid tetradecyl vinyl ester and Tricosane were found to be abundant and these compounds have demonstrated antioxidant, antimicrobial, anticancer, anti-inflammatory and antimutagenic properties. This work provides a detailed analysis of the juice's chemical composition and highlights its significant therapeutic potential. The results suggest that cashew apple juice could be a valuable source for developing pharmaceuticals, nutraceuticals and functional foods. Future research will aim to isolate these compounds and explore their individual therapeutic applications, paving the way for more targeted and effective treatments based on natural bioactive substances.

Conclusions

The GC-MS analysis of cashew apple juice revealed a diverse array of chemical compounds that contributed to its rich

nutritional profile, distinctive flavor and potential health benefits. There were more phenolic compounds and a modest number of flavonoids in the fruits of *A. occidentale*. The pharmaceutical sector has experienced a reduction in the use of natural products, primarily due to the incompatibility between high-throughput screening methods and conventional natural product extract libraries. In further studies, individual active compounds will be isolated by chromatographic methods and the fractions will be assessed independently by FTIR and NMR to determine the nature compounds, structure and functional group of the compound to be transformed into a new active medicament.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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References

[1]. Patel, D. K., 2015. Plants as a Source of Medicine. *Medicinal & Aromatic Plants*, 3(1), 2167. https://doi.org/10.4172/2167-0412.S3-e001

[2]. Biswas, S. J., Bhattacharjee, N. and Khuda-Bukhsh, A. R., 2008. Efficacy of a plant extract (Chelidonium majus L.) in combating induced hepatocarcinogenesis in mice. *Food and Chemical Toxicology*, 46(5), 474-1487. https://doi.org/10.1016/j.fct.2007.12.009

[3]. Farooqi, S. S., Naveed, S., Qamar, F., Sana, A., Farooqi, S. H., Sabir, N., Mansoor, A. and Sadia, H., 2024. Phytochemical analysis, GC-MS characterization and antioxidant activity of Hordeum vulgare seed extracts. *Heliyon*, 10(6), e27297. https://doi.org/10.1016/j.heliyon.2024.e27297

[4]. Seedevi, P., 2024. Chemical characterization and biological activity of leaf extract from Parthenium hysterophorous. *Biomass Conversion and Biorefinery*, 14(16), 18459-18467. https://doi.org/10.1007/s13399-023-03866-x

[5]. Konappa, N., Udayashankar, A. C., Krishnamurthy, S., Pradeep, C. K., Chowdappa, S. and Jogaiah, S., 2020. GC–MS analysis of phytoconstituents from Amomum nilgiricum and molecular docking interactions of bioactive serverogenin acetate with target proteins. *Scientific reports*, 10(1), 16438. https://doi.org/10.1038/s41598-020-73442-0

[6]. Jeyavishnu, K., Thulasidharan, D., Shereen, M. F. and Arumugam, A., 2021. Increased revenue with high value-added products from cashew apple (Anacardium occidentale L.) addressing global challenges. *Food and Bioprocess Technology*, 14, 985-1012. https://doi.org/10.1007/s11947-021-02623-0

[7]. Britannica, T., Editors of Encyclopaedia (2024, September 14). *cashew*. *Encyclopedia Britannica*. https://www.britannica.com/plant/cashew

[8]. Griffin, L. E. and Dean, L. L., 2017. Nutrient composition of raw, dry-roasted, and skin-on cashew nuts. *Journal of Food Research*, 6(6), 13-28. https://doi.org/10.5539/jfr.v6n6p13

[9]. Mitchell, J. D., Pell, S. K., Bachelier, J. B., Warschefsky, E. J., Joyce, E. M., et al., 2022. Neotropical Anacardiaceae (cashew family). *Brazilian Journal of Botany*, 45(1), 139-180. https://doi.org/10.1007/s40415-022-00793-5

[10]. Muhammad, A. and Muhammad, T., 2021. Medicinal uses of cashew (Anacardium occidentale). *Journal of Science Technology and Research*, 2(1), 1-10. https://philpapers.org/rec/MUHMUO

[11]. Kandaswamy, S., Swarupa, V. M., Sur, S., Choubey, G., Devarajan, Y. and Mishra, R., 2023. Cashew nutshell oil as a potential feedstock for biodiesel production: An overview. *Biotechnology and Bioengineering*, 120(11), 3137-3147. https://doi.org/10.1002/bit.28515

[12]. Salehi, B., Gültekin-Özgüven, M., Kirkin, C., Özçelik, B., Morais-Braga, M. F. B., et al., 2020. Antioxidant, antimicrobial, and anticancer effects of anacardium plants: an ethnopharmacological perspective. *Frontiers in Endocrinology*, 11,295. https://doi.org/10.3389/fendo.2020.00295

[13]. de Carvalho Melo-Cavalcante, A. A., de Moura Dantas, S. M. M., de Sousa Leite, A., Matos, L. A., de Castro e Sousa, J. M., Picada, J. N. and da Silva, J., 2011. In vivo antigenotoxic and anticlastogenic effects of fresh and processed cashew (Anacardium occidentale) apple juices. *Journal of Medicinal Food*, 14(7-8), 792-798. https://doi.org/10.1089/jmf.2010.0153

[14]. Melo-Cavalcante, A. A., Picada, J. N., Rubensam, G. and Henriques, J. A., 2008. Antimutagenic activity of cashew apple (Anacardium occidentale Sapindales, Anacardiaceae) fresh juice and processed juice (cajuína) against methyl methanesulfonate, 4-nitroquinoline N-oxide and benzo [a] pyrene. *Genetics and Molecular Biology*, 31(3), 759-766. https://doi.org/10.1590/S1415-47572008000400024

[15]. da Silva, R. A., Liberio, S. A., do Amaral, F. M., do Nascimento, F. R. F., Torres, L. M. B., Neto, V. M. and Guerra, R. N. M., 2016. Antimicrobial and antioxidant activity of Anacardium occidentale L. flowers in comparison to bark and leaves extracts. *Journal of Biosciences and Medicines*, 4(4), 87-99. https://doi.org/10.4236/jbm.2016.44012

[16]. Sivaprakasam, S., Chinnaiyan, U., Varatharajan, S., Uthayasuryan, E., Chandrasekaran, M., Paramasivam, S. and Ramasamy, P., 2025. Unveiling the Physicochemical Attributes and Antioxidant Potential of Cashew Apple Juice Varieties. *Applied Fruit Science*, *67*(2),74. https://doi.org/10.1007/s10341-025-01303-z

[17]. Dedehou, E. S., Dossou, J., Ahohuendo, B., Saidou, A., Ahanchede, A., and Soumanou, M. M., 2015. Optimization of cashew (Anacardium occidentale L.) apple juice's clarification process by using cassava and rice starch. *Journal of Applied Biosciences*, 95,8989-9002. https://doi.org/10.4314/jab.v95i1.9

[18]. Priyatharsini, S., Uma, C., and Sivagurunathan, P., 2018. Evaluation of Bioactive Compound from Cashew Apple Juice by Gas Chromatography–Mass Spectrum Analysis. *International Journal of Pharmaceutical & Biological Archive*, 9(4), 242-245. https://www.researchgate.net/publication/330873988_Evaluation_of_Bioactive_Compound_from_Cashew_Apple_Juice_by_Gas_Chromatography-Mass_Spectrum_Analysis

[19]. Vynne, N. G., Månsson, M., Nielsen, K. F., and Gram, L., 2011. Bioactivity, chemical profiling, and 16S rRNA-based phylogeny of Pseudoalteromonas strains collected on a global research cruise. *Marine Biotechnology*, 13, 1062-1073. https://doi.org/10.1007/s10126-011-9369-4

[20]. Sivagurunathan, P., Sivasankari, S., and Muthukkaruppan, S. M., 2011. Determination of phenolic compounds in red variety of cashew apple (Anacardium occidentale L.) by GC-MS. *Journal of Basic and Applied Biology*, 5(1&2), 227-231.

https://www.researchgate.net/profile/Sivagurunathan-Paramasivam/publication/224859199_DETERMINATION_OF_PHENOLIC_COMPOUNDS_IN_RED_VARIETY_OF_CASHEW_APPLE_Anacardium_occidentale_L_BY_GC-MS/links/02bfe511e0703d6f4b000000/DETERMINATION-OF-PHENOLIC-COMPOUNDS-IN-RED-VARIETY-OF-CASHEW-APPLE-Anacardium-occidentale-L-BY-GC-MS.pdf

[21]. Oloniyo, R. O., Mepa, H. O., and Orishagbemi, C. O., 2024. GC-MS Bioactive Compounds Characterization and Antioxidant Activities of Defatted and Un-Defatted Cashew (Anacardium Occidentale L.) Kernel Flour, *Journal of Waste Management and Disposal*. 7,101. https://www.researchgate.net/profile/Rebecca-Oloniyo/publication/378831055_GC-MS_Bioactive_Compounds_Characterization_and_Antioxidant_Activities_of_Defatted_and_UnDefatted_Cashew_Anacardium_Occidentale_L_Kernel_Flour/links/65ec4199b1906066b2858897/GC-MS-Bioactive-Compounds-Characterization-and-Antioxidant-Activities-of-Defatted-and-Un-Defatted-Cashew-Anacardium-Occidentale-L-Kernel-Flour.pdf

[22]. Ghosh, A., Majumder, S., Saha, S., Sarkar, S., and Bhattacharya, M., 2021. Gas Chromatography-Mass Spectrometry profiling, and evaluation of antioxidant and antibacterial activity of Albizia spp. *Nusantara Bioscience*, *13*(2), 177-184. https://doi.org/10.13057/nusbiosci/n130207

[23]. Garruti, D. S., Franco, M. R. B., da Silva, M. A. A., Janzantti, N. S., and Alves, G. L., 2006. Assessment of aroma impact compounds in a cashew apple-based alcoholic beverage by GC-MS and GC-olfactometry. *LWT-Food Science and Technology*, *39*(4), 373-378. https://doi.org/10.1016/j.lwt.2005.02.006