INTI JOURNAL | eISSN:2600-7320
Vol.2022:14

Identification of the Phytochemicals in *Passiflora edulis* f. *edulis* and *Passiflora edulis* f. *flavicarpa*

Poornima Jeyasekaran[1*] & M. Deepa[2]

[1]Department of Food Science and Nutrition, The American College, Madurai, Tamil Nadu, India 625001.
[2]Department of Food Science and Nutrition, Periyar University, Salem, Tamil Nadu, India 636011.

***Email:** poornimajeyasekaran@yahoo.co.in

Abstract

Phytochemicals are abundant in plants and are non-nutritive, bioactive compounds that help prevent degenerative diseases and support overall health. These chemical constituents in food possess protective properties that can reduce the risk of chronic illnesses. The objective of this study is to identify the chemical components of two varieties of passion fruit, *Passiflora edulis f. edulis* and *Passiflora edulis f. flavicarpa,* naturally available in the Thandikudi hills, Tamil Nadu, India, and to compare the sensory attributes of squashes prepared from these two varieties. A high-tech instrument, the JASCO FTIR Spectrophotometer (FTIR-4600), was employed to identify the chemical constituents in the fruit pulps. The results revealed the presence of alkanes, primary alcohols, aldehydes, and aromatic compounds. Inferential statistical analysis of the sensory evaluation indicated that panelists rated the *Passiflora edulis f. edulis* squash as more acceptable than the *Passiflora edulis f. flavicarpa* squash on the 9-point hedonic scale. This study can be further extended by comparing other varieties of passion fruit and exploring their potential for commercialization.

Keywords

Phytochemicals, Passion fruit, Organoleptic evaluation

Introduction

Fruits, whether consumed fresh or processed, are recognized as rich sources of phytochemicals. Approximately 20,000 phytochemicals have been identified from fruits, vegetables, and grains (Patra, 2012). Historically, various fruits have also been used in traditional medicine since early civilizations (Scartezzini & Speroni, 2007).

Sugars, acids, and polysaccharides contribute significantly to the phytochemical content in fruits and are known for their medicinal properties (Escobedo-Avellaneda et al., 2014). These bioactive compounds exhibit various health benefits, including antioxidant, antibacterial, antifungal, antiviral, cholesterol-lowering, antithrombotic, and anti-inflammatory effects (Schreiner & Huyskens-Keil, 2006). In addition to fruits, other plant parts such as bark, leaves, seeds, stems, roots, twigs, and sap have been used in folk medicine for treating ailments such as coughs, fever, asthma, diarrhea, indigestion, and skin diseases (Muthu et al., 2006).

Submission: 30 November 2021; **Acceptance:** 7 May 2022

Passion fruits are less prominent in the commercial fruit market compared to other fruits and are thus not widely cultivated on a large scale. Indigenous tropical fruits like passion fruit remain underutilized despite their potential for commercialization, often due to limited awareness and regional availability. While passion fruits are highly nutritious, their medicinal benefits are relatively unknown (Khoo et al., 2010). Dietary phytochemicals are broadly categorized as phenolics, alkaloids, nitrogen-containing compounds, organosulfur compounds, phytosterols, and carotenoids (Liu, 2004).

According to the 2010 review of the Dietary Guidelines for Americans, individuals on a 2000-kcal diet are advised to consume at least 8 to 9 servings of fruits and vegetables per day—at least 4 servings of fruits and 5 of vegetables (USDA, 2010). However, there remains a significant gap between these recommendations and actual consumption. Bridging this gap requires increased public awareness of the health benefits of incorporating fruits and vegetables into a balanced diet (Liu, 2004).

While few clinical trials have assessed the effects of fruit and vegetable intake on cardiovascular disease (CVD) in humans, a randomized controlled trial by Watzl et al. (2005) demonstrated promising results. Similarly, a population-based case-control study conducted in the San Francisco Bay Area found that fruit and vegetable consumption was associated with a reduced risk of pancreatic cancer (Chan et al., 2005).

Multiple studies suggest that a high intake of polyphenol-rich foods may offer cardiovascular benefits and serve as chemo-preventive agents against cancers, bladder dysfunction, and neurodegenerative diseases such as Alzheimer's (De Pascual-Teresa, 2010). In particular, flavonoids—one of the main types of phenolics—exhibit antiallergic, anticancer, anticonvulsant, antidiabetic, antihypertensive, anti-inflammatory, antimicrobial, antioxidant, antiplasmodial, antiviral, and antiulcer properties, thereby helping reduce the risk of severe diseases (De Conti Lourenço, 2013).

Materials and Methods

The purple and yellow passion fruits were harvested in the Thandikudi hills, Western Ghats (Lower Pulney Hills), Tamil Nadu, India. The collected fruit samples were taken to the central instrumentation laboratory (ACCIC) for the functional component analysis using Fourier Transform Infrared Spectroscopy (FTIR). The external appearance of the two varieties is shown in Figure 1 (Purple passion fruit) and Figure 2 (Yellow passion fruit).


Figure 1. Purple passion fruit


Figure 2. Yellow passion fruit

Sample analysis procedure in FTIR

Where the samples are in a liquid or solid form, the intensity of the spectral features is determined by the thickness of the sample, and typically this sample thickness cannot be more than a few tens of microns. The technique of Attenuated Total Reflectance (ATR) has transformed solid and liquid sample analyses because it combats the most challenging facets of infrared analyses, namely sample preparation and spectral reproducibility (James et al. 2003). The instrument used for this analysis is shown in Figure 3, which displays the JASCO FTIR Spectrophotometer (FTIR-4600).

Figure 3. JASCO FTIR Spectrophotometer (FTIR-4600).

Steps to interpret FTIR

Identification of the number of absorption bands in the full IR spectrum. If the sample has a simple spectrum with fewer than 5 absorption bands, the compounds analyzed are likely simple organic compounds, small molecular weight, or inorganic compounds.

Identifying single bond area (2500-4000 cm^{-1}). There are numerous peaks in this area: A broad absorption band in the range of between 3650 and 3250 cm^{-1}, indicating a hydrogen bond. This band confirms the presence of hydrate (H2O), hydroxyl (-OH), ammonium, or amino.

Identifying the triple bond region (2000-2500 cm^{-1}) that is if there is a peak at 2200 cm^{-1}, it should be absorption band of C≡C. Identifying the double bond region (1500-2000 cm^{-1}) Double bound can be as carbonyl (C = C), amino (C = N), and azo (N = N) groups. 1850 - 1650 $cm^{-1}$for carbonyl compounds. Above 1775 cm^{-1}, conforming active carbonyl groups such as anhydrides, halide acids, or halogenated carbonyl, or ring-carbonyl carbons, such as lactone, or organic carbonates.

Identifying the fingerprint region (600-1500 cm^{-1}). This area is characteristically specific and unique, but several identifications can be found between 1000 and 880 cm^{-1} for multiple band absorption. There are absorption bands at 1650, 3010, and 3040 cm^{-1} (Nandiyanto et al., 2019).

Squash preparation

Fruit beverages are prepared from fruit juices or pulp scooped and preserved by chemical preservatives or by heat application. Squash is a ready-to-drink product, which is prepared by mixing a measured quantity of fruit juice or pulp with sugar, acid, and other ingredients. As per FSSAI specifications, squash should contain a minimum of 25 per cent fruit content in the finished product, and the total soluble solids content should not be less than 40 Brix. The acidity of the squash should not be more than 3.5 per cent as anhydrous citric acid. Purple passion fruits are used for making squash preparation.

The washed fruits need to be cut in half, followed by scooping out the pulp and seeds. Place the mixture of pulp and seed in a pan and heat over a low heat. This is to soften the pulp and allow the seeds to be separated. Seeds are separated by a filtration process, which is then followed by the addition of sugar. Boil the mixture for 10 minutes till the sugar dissolves completely with continuous stirring. The maximum permissible limit of preservatives in squash is 350 ppm of sulphur dioxide or 600 ppm of benzoic acid. Sodium benzoate is used as a preservative. Squash contains 40 to 50 percent sugar and about 1.0 percent acid. They have to be diluted in the ratio of 1:4 before consumption.

FSSAI specifications for squash are: (i) minimum per cent of total soluble solids (TSS) is 40, and (ii) minimum per cent of fruit juice is 25. The following permissible limit of the preservative is sulphur dioxide, 350 ppm, or as benzoic acid, 600 ppm.

Table 1. Standardised ingredients for squash making

Ingredients	Quantity
Pulp	600ml
Sugar	900g
Water	900ml
Citric Acid	8g
Sodium benzoate	2g

The prepared squashes were analysed for the sensory attributes using a 9-Point hedonic scale. The yellow fruit squash and purple fruit squash were compared with the sensory attributes of the lemon squash evaluated by Emelike and Akusu (2019).

Results and Discussion

The following tables and graphs are the results of the yellow and purple fruit pulp analysed in FTIR spectroscopy.

Table 2. Functional Components in Yellow Passion fruit pulp

S.NO	ABSORPTION(Cm-1)	GROUP	COMPOUND
1	3303.46	C-H Stretching	Alkyne
2	2949.59	C-H Stretching	Alkane
3	1738.51	C=O Stretching	Aldehyde
4	1641.13	C=N Stretching	Imine/Oxime
5	1368.25	C-H Bending	Alkane
6	1215.9	C-O Stretching	Vinyl ether
7	1108.87	C-O Stretching	Primary alcohol

The peak values of the yellow passion fruit pulp reveal the presence of Alkyne 3303.46 cm^{-1}, alkane 2949.59 cm^{-1}, aldehyde 1738.51 cm^{-1}, vinyl ether 1215.9 $cm^{-1,}$ and primary alcohol 1108.87 cm^{-1}.

Table 3. Functional Components in Purple Passion fruit pulp

S.NO	ABSORPTION(Cm-1)	GROUP	COMPOUND
1	3312.53	C-H Stretching	Alkyne
2	2926.45	C-H Stretching	Alkane
3	1278.25	C-N Stretching	Aromatic amine
4	1983.52	C-H Bending	Aromatic compound
5	1385.67	C-H Bending	Alkane
6	1014.37	C- F Stretching	Fluoro compound
7	1112.5	C-O Stretching	Primary alcohol

The table presents the presence of functional compounds in the purple passion fruit pulp. The FTIR absorption peaks confirm the presence of the following compounds: alkyne at 3312.53 cm^{-1}, alkane at 2926.45 cm^{-1}, aromatic amine at 1278.25 cm^{-1}, aromatic compound at 1983.52 cm^{-1}, primary alcohol at 1112.5 cm^{-1}, and fluoro compound at 1014.37 cm^{-1}.

Table 4. Comparison of Sensory Attributes between Yellow Passion Fruit Squash and Lemon Squash

Quality Parameters	Yellow Passion Fruit Squash (Mean, X̄)	Yellow Passion Fruit Squash (SD, s)	Lemon Squash (Mean, μ)	Lemon Squash (SD, σ)	Sample Size (n)	t-Value	t Critical (0.05, df = 24)	p-Value
Colour and Appearance	7.2	0.4	7.5	0.2	25	3.54	-1.71	0.00
Flavour	7.5	0.3	8.0	0.2	25	1.10	-1.71	0.21
Consistency	8.2	0.2	8.3	0.1	25	-2.18	-1.71	0.04
Taste	7.5	0.4	7.8	0.2	25	3.87	-1.71	0.00
Overall Acceptability	7.1	0.3	8.1	0.2	25	2.04	-1.71	0.05

Decision: Reject the null hypothesis – there is a statistically significant difference.

Table 5. Comparison of sensory attributes between purple passion fruit squash and lemon squash

Quality Parameters	Purple Passion fruit Squash (Present study) Mean (X bar)	Purple Passion fruit Squash (Present study) standard deviation (s)	Lemon squash (Emelike and Akusu, 2019) Mean (μ)	Lemon squash (Emelike and Akusu, 2019) standard deviation (σ)	Sample size (n)	2 tailed t test	RISK ALPHA t(0.05), 24	P(t)

Colour and Appearance	8.6	0.5	7.5	0.2	25	5.50	-1.71	1.48E-05
Flavour	8.8	0.4	8.0	0.2	25	5.04	-1.71	4.77E-05
Consistency	8.1	0.4	8.3	0.1	25	3.65	-1.71	1.57E-03
Taste	8.0	0.5	7.8	0.2	25	5.10	-1.71	4.12E-05
Overall acceptability	8.3	0.5	8.1	0.2	25	4.68	-1.71	1.19E-04

Decision: Reject the null hypothesis – there is a statistically significant difference.

The colour is more impressive than the reference value. The flavour is better than the reference value. The consistency is lower with the reference value. The taste is much better than the reference value. The overall acceptability is higher when compared with the lemon squash. Thus, purple passion fruit squash has better aroma and appearance, which makes it more acceptable compared to the citrus lemon squash.

Conclusions

This study confirms the presence of functional compounds in the passion fruit samples, supporting their medicinal properties. As such, passion fruits can be utilized for various pharmaceutical and nutraceutical applications. Regular consumption of these fruits is likely to confer health benefits and support their use as functional foods. Although the importance of fruits in the diet is widely acknowledged, many individuals avoid them due to time constraints related to peeling and cutting, and because fruits are seasonal, making regular consumption challenging.

To address this, preparing passion fruit squash is a convenient and ready-to-consume alternative, especially for those with busy lifestyles. The findings indicate that purple passion fruit squash has superior color, flavor, taste, and overall acceptability when compared to yellow passion fruit squash. Future innovations could include the development of additional products such as jams, jellies, and cakes. Furthermore, the researcher intends to pursue advanced spectroscopic techniques to elucidate the structure and quantify the bioactive compounds. This will support the identification of functional components in the peel and rind of the fruits, potentially leading to the formulation of preventive and curative medicinal products.

Acknowledgments

The researcher extends her heartfelt gratitude to Mr. A. K. JeyaPrakash, Mr. R. Mahesh Narayanan, and Mr. G. Deepan, planters from Pattiveeranpatti, for consistently providing freshly ripened passion fruits for the study. Special thanks are also due to Mr. N. Jeyasekaran and Mr. S. Jeyasudhan for their assistance in transporting the fruits to the laboratory. Sincere appreciation is extended to the Central Instrumentation Laboratory of The American College, Madurai, for providing the necessary facilities. The researcher is also thankful to Dr. Poongodi Vijayakumar and Dr. M. Deepa for their valuable guidance. Finally, gratitude is expressed to Mr. A. D. C. Rajasabai for his support in the statistical analysis of the study.

References

Adebayo Mujedu, K., Ab-Kadir, M. A., & Ismail, M. (2020). A review on self-compacting concrete incorporating palm oil fuel ash as a cement replacement. *Construction and Building Materials, 258*, 119541. https://doi.org/10.1016/j.conbuildmat.2020.119541

Chan, J. M., Wang, F., & Holly, E. A. (2005). Vegetable and fruit intake and pancreatic cancer in a population-based case-control study in the San Francisco Bay Area. *Cancer Epidemiology, Biomarkers & Prevention, 14*(9), 2093–2097.

De Conti Lourenço, R. M. C., da Silva Melo, P., & De Almeida, A. B. A. (2013). Flavonoids as antifungal agents. In M. Razzaghi-Abyaneh & M. Rai (Eds.), *Antifungal metabolites from plants* (pp. 257–272). Springer. https://doi.org/10.1007/978-3-642-38076-1_10

De Pascual-Teresa, S., Moreno, D. A., & García-Viguera, C. (2010). Flavanols and anthocyanins in cardiovascular health: A review of current evidence. *International Journal of Molecular Sciences, 11*(4), 1679–1703. https://doi.org/10.3390/ijms11041679

Emelike, N., & Akusu, O. (2019). Quality attributes of jams and marmalades produced from some selected tropical fruits. *Journal of Food Processing & Technology, 10*(5), 1–7. https://doi.org/10.4172/2157-7110.1000790

Escobedo-Avellaneda, Z., Janet, G.-U., Valdez-Fragosoa, A., Antonio, T., & Welti-Chanes, J. (2014). Phytochemicals and antioxidant activity of juice, flavedo, albedo, and comminuted orange. *Journal of Functional Foods, 6*, 470–481.

James, P. S., & Hinson-Smith, V. (2003). Product review: The endearing FTIR spectrophotometer. *Analytical Chemistry, 75*(1), 37A–39A.

Khoo, H. E., Prasad, K. N., Kong, K. W., & others. (2010). A review on underutilized tropical fruits in Malaysia. *Guangxi Agricultural Sciences, 41*(7), 698–702.

Liu, R. H. (2004). Potential synergy of phytochemicals in cancer prevention: Mechanism of action. *Journal of Nutrition, 134*(12 Suppl), 3479S–3485S.

Muthu, C., Ayyanar, M., Raja, N., & Ignacimuthu, S. (2006). Medicinal plants used by traditional healers in Kancheepuram District of Tamil Nadu, India. *Journal of Ethnobiology and Ethnomedicine, 2*, 43. https://doi.org/10.1186/1746-4269-2-43

Nandiyanto, A. B. D., Oktiani, R., & Ragadhita, R. (2019). How to read and interpret FTIR spectroscope of organic material. *Indonesian Journal of Science & Technology, 4*(1), 97–118. https://doi.org/10.17509/ijost.v4i1.15806

Patra, A. K. (2012). *Dietary phytochemicals and microbes*. Springer. https://doi.org/10.1007/978-94-007-3926-0

Scartezzini, P., & Speroni, E. (2000). Review on some plants of Indian traditional medicine with antioxidant activity. *Journal of Ethnopharmacology, 71*(1–2), 23–43. https://doi.org/10.1016/S0378-8741(00)00213-2

Schreiner, M., & Huyskens-Keil, S. (2006). Phytochemicals in fruit and vegetables. *Critical Reviews in Plant Sciences, 25*(3), 267–278. https://doi.org/10.1080/07352680600634721

U.S. Department of Agriculture. (2010). *Dietary guidelines for Americans 2010* (7th ed.). U.S. Government Printing Office.

Watzl, B., Kulling, S. E., Möseneder, J., Barth, S. W., & Bub, A. (2005). A 4-wk intervention with high intake of carotenoid-rich vegetables and fruit reduces plasma C-reactive protein in healthy, nonsmoking men. *American Journal of Clinical Nutrition, 82*(5), 1052–1058. https://doi.org/10.1093/ajcn/82.5.1052