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Qualitative phytochemical analysis of passion fruit (*Passiflora edulis* Sims) seed extracts

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Abstract

Yellow passion fruit (*Passiflora edulis* Sims) is widely cultivated for its nutritional and commercial value, generating a considerable quantity of seed waste during juice processing. Although the pulp has been extensively investigated, the phytochemical composition of the seeds remains comparatively unexplored despite their potential as a valuable source of bioactive compounds. The present study aimed to perform a preliminary qualitative phytochemical screening of yellow passion fruit seed extracts prepared using solvents of different polarities, namely chloroform, methanol, and distilled water. Mature seeds were separated from fresh fruits, washed thoroughly, shade-dried, powdered, and subjected to cold maceration extraction. The obtained extracts were screened using standard qualitative phytochemical methods to detect major classes of secondary metabolites.

The qualitative analysis revealed that terpenoids were present in all three solvent extracts. Steroids, phytosterols, and anthraquinone glycosides were detected exclusively in the chloroform extract, whereas alkaloids, phenols, flavonoids, saponins, tannins, phlobatannins, lignins, quinones, anthocyanins, and coumarins were not detected in any of the extracts. The findings demonstrate that solvent polarity significantly influences the recovery of phytochemicals, with the non-polar chloroform extract exhibiting a broader spectrum of lipophilic bioactive constituents than the polar solvents.

This preliminary investigation indicates that yellow passion fruit seeds possess valuable phytochemical constituents and may serve as a promising agro-industrial by-product for future nutraceutical, pharmaceutical, and functional food applications. Further quantitative phytochemical characterization and biological activity studies are recommended to validate these findings.

Keywords: *Passiflora edulis* Sims, yellow passion fruit, seed extracts, phytochemical screening, cold maceration, bioactive compounds

Introduction

Yellow passion fruit (*Passiflora edulis* Sims) belongs to the family Passifloraceae and is one of the most commercially important tropical fruit crops cultivated throughout South America, Africa, Asia, and several subtropical regions of the world. The fruit is highly appreciated for its distinctive aroma, pleasant flavour, nutritional composition, and medicinal properties. Owing to its increasing demand in the juice and beverage industries, large quantities of passion fruit are processed annually, resulting in substantial amounts of agro-industrial waste consisting mainly of peels and seeds.

Among these by-products, the seeds account for approximately 10–20% of the total fruit weight. Although they are generally discarded during industrial processing, several studies have suggested that passion fruit seeds contain numerous biologically active compounds that may possess antioxidant, antimicrobial, anti-inflammatory, hypolipidemic, and anticancer properties. Consequently, the utilization of these underexploited seed residues has attracted increasing attention as part of sustainable waste valorization strategies.

Plant-derived phytochemicals are naturally occurring secondary metabolites that play essential roles in plant defense and contribute significantly to human health. Major classes of phytochemicals include alkaloids, flavonoids, phenolic compounds, terpenoids, steroids, tannins, saponins, glycosides, phytosterols, coumarins, quinones, lignins, and anthocyanins. These compounds have been widely reported to exhibit diverse pharmacological activities, including antioxidant, antimicrobial, anti-inflammatory, anticancer, cardioprotective, hepatoprotective, and immunomodulatory effects. Therefore, qualitative phytochemical screening represents an important preliminary step in identifying promising plant materials for future pharmaceutical and nutraceutical development.

The efficiency of phytochemical extraction largely depends on the polarity of the extraction solvent. Polar solvents such as methanol and water preferentially dissolve hydrophilic constituents including phenolic compounds and flavonoids, whereas non-polar solvents such as chloroform are more efficient in extracting lipophilic constituents including steroids, terpenoids, phytosterols, and certain glycosides. Consequently, comparative solvent extraction provides valuable information regarding the distribution of phytochemicals within plant tissues and assists in selecting suitable extraction systems for further chemical characterization.

Although extensive investigations have been conducted on the phytochemical composition of passion fruit peel and

pulp, comparatively fewer studies have focused specifically on the seeds of yellow passion fruit (*Passiflora edulis* Sims). Most available reports primarily emphasize seed oil composition and fatty acid profiles, while comprehensive qualitative phytochemical investigations remain limited. The present study was therefore undertaken to evaluate the preliminary qualitative phytochemical composition of chloroform, methanol, and distilled water extracts prepared from yellow passion fruit seeds using standard phytochemical screening techniques.

The findings of this investigation are expected to provide baseline information regarding the phytochemical composition of passion fruit seed extracts and contribute to the sustainable utilization of this agro-industrial by-product. Furthermore, the results may facilitate future studies involving quantitative phytochemical estimation, compound isolation, antioxidant evaluation, antimicrobial assessment, and other pharmacological investigations aimed at developing value-added functional foods and natural therapeutic products.

The objectives of this study were:

1. To perform physical analysis of yellow passion fruits.
2. To collect and shade-dry the yellow passion fruit seeds.
3. To prepare and collect extracts from yellow passion fruit seeds.
4. To analyze the phytochemical composition of yellow passion fruit seed extracts.

Materials and Methods

1. Collection and Authentication of Plant Material

Fresh mature yellow passion fruits (*Passiflora edulis* Sims) were collected from the researcher's kitchen garden located in Nargund Taluk, Gadag District, Karnataka, India, during the harvesting season. The hybrid variety (Kaveri) was originally procured from the ICAR–Indian Institute of Horticultural Research (IIHR), Bengaluru. The collected fruits were healthy, fully matured, and free from visible signs of insect infestation or mechanical damage. Botanical authentication of the plant material was carried out by the Botanical Survey of India (BSI), Southern Regional Centre, Coimbatore, Tamil Nadu, India, and a voucher specimen was deposited for future reference.

2. Preparation of Passion Fruit Seeds

The fruits were washed thoroughly under running tap water followed by rinsing with distilled water to remove adhering dust and surface contaminants. The fruits were cut longitudinally using a sterile stainless-steel knife, and the seeds were manually separated from the pulp.

The separated seeds were repeatedly washed with distilled water until all adhering pulp residues were completely removed. The cleaned seeds were spread uniformly on clean blotting sheets and shade-dried at ambient laboratory temperature (25–30°C) for 7–10 days until a constant weight was obtained. Shade drying was preferred to minimize thermal degradation of heat-sensitive phytochemicals.

The dried seeds were ground into a fine powder using an electric laboratory gseeder and passed through a fine mesh sieve to obtain uniform particle size. The powdered samples were transferred into airtight polyethylene containers and stored at 4°C until further extraction.

3. Preparation of Seed Extracts

Cold maceration was employed for the extraction of phytochemicals because it minimizes thermal degradation of bioactive constituents and is suitable for preliminary phytochemical investigations.

Approximately 25 g of seed powder was mixed separately with 250 mL of chloroform, methanol, and distilled water using a 1:10 (w/v) ratio. Each mixture was transferred into sterile conical flasks, tightly sealed with aluminium foil, and maintained at room temperature for 24 hours with intermittent shaking to facilitate efficient solvent penetration and extraction of soluble phytochemicals.

After extraction, each mixture was filtered through Whatman No. 1 filter paper. The filtrates obtained represented the chloroform, methanol, and distilled water extracts, respectively. The extracts were collected in sterile amber-coloured bottles and stored at 4°C until phytochemical analysis.

4. Qualitative Phytochemical Screening

The qualitative phytochemical screening of all three extracts was carried out using standard phytochemical procedures described by Trease and Evans (2009), Harborne (1998), and Sofowora (2008)[5, 14, 15]. The presence or absence of various classes of secondary metabolites was determined based on characteristic colour changes or precipitate formation following the addition of specific reagents.

The phytochemicals investigated included:

- Alkaloids
- Phenols
- Flavonoids
- Terpenoids
- Steroids
- Saponins
- Tannins
- Anthraquinone glycosides
- Phlobatannins
- Phytosterols
- Lignins
- Quinones
- Anthocyanins
- Coumarins

Each qualitative test was performed in triplicate to ensure consistency of observations.

5. Phytochemical Screening Procedures

Raw Material Collection

Yellow passion fruits were obtained from the research scholar’s kitchen garden in NargundTaluk, Gadag District, and Karnataka, India. The *Kaveri* hybrid seeds were sourced from the Indian Institute of Horticultural Research (ICAR-IIHR), Bengalore. Mature, undamaged fruits were harvested during the 2023–2024[9, 18] monsoon season.

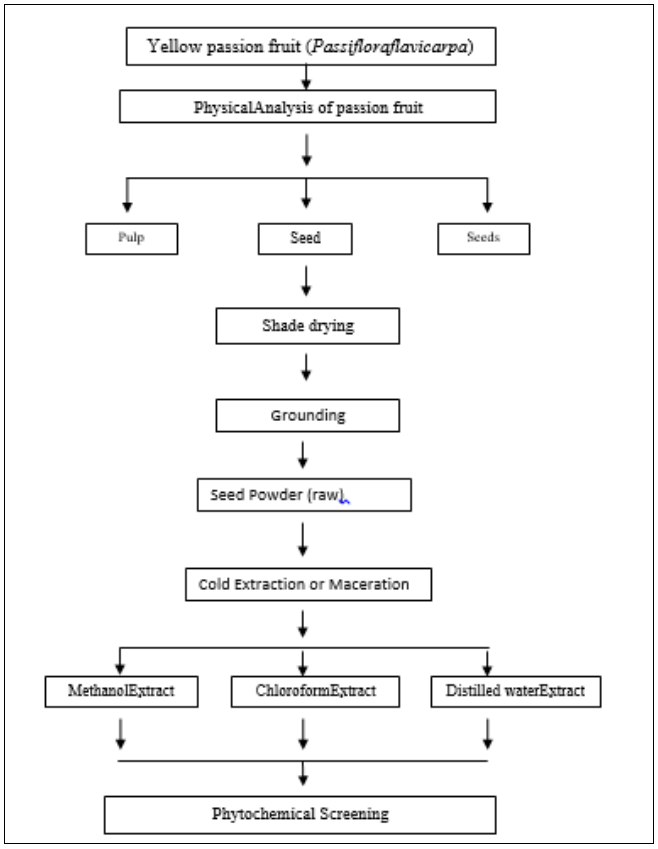

Fig 1: A Scheme of the experiment for the determination of Phytochemicaland Qualitative Analysis of Yellow Passion Fruit (*Passiflora* spp.) seeds Extracts.

PhysicalAnalysis of passion fruit:
Ten fresh yellow passion fruits were selected when fully yellow and washed thoroughly. Average weight, lengthand diameter were measured. Pulp, seedsand seeds were separated, weighedand recorded. Seeds were shade-dried for five days and stored in paper envelopes. Average weight was calculated using:

Average weight = Sum of 10 fruit weights / Number of fruits

Collection of passion fruit seeds which are shade dried.
The passion fruits were picked when they turned yellow in colour. The fruits were washed thoroughly in a small bowl with clean water and then cut open with a sharp knife. The pulp with seeds was separated from the seeds. The seeds were placed on paper towels and blotted dry. They were then allowed to dry completely in a shaded area for five days and subsequently stored in paper envelopes.
Extraction Procedure
The dried seeds were ground into powder and extracted using the cold maceration method. Three solvents—chloroform, methanoland distilled water—were used. Each extraction was carried out by combining 25 g of seed powder with 250 ml of solvent in a 1:10 (w/v) ratio, followed by maceration for 24 hours at room temperature with intermittent shaking. The filtrates were collected and stored in airtight, light-protected containers

5.1 Test for Alkaloids (Dragendorff's Test)
Approximately 2 mL of each extract was acidified with dilute hydrochloric acid and filtered. A few drops of Dragendorff's reagent were added to the filtrate. The formation of an orange or reddish-brown precipitate indicated the presence of alkaloids.

5.2 Test for Phenolic Compounds (Ferric Chloride Test)
Two millilitres of each extract were treated with a few drops of 5% ferric chloride solution. Development of a deep blue, green, or black colour indicated the presence of phenolic compounds.

5.3 Test for Flavonoids (Shinoda Test)
To 2 mL of each extract, a small quantity of magnesium ribbon followed by concentrated hydrochloric acid was added. Development of a pink, crimson, or reddish colour confirmed the presence of flavonoids.

5.4 Test for Terpenoids (Salkowski Test)
Two millilitres of extract were mixed with chloroform, followed by careful addition of concentrated sulphuric acid along the wall of the test tube. Formation of a reddish-brown interface indicated the presence of terpenoids.

5.5 Test for Steroids (Liebermann–Burchard Test)
Each extract was treated with acetic anhydride followed by concentrated sulphuric acid. The appearance of a bluish-green colour confirmed the presence of steroids.

5.6 Test for Saponins (Froth Test)
Approximately 5 mL of extract was vigorously shaken with distilled water for several minutes. Formation of a stable persistent froth indicated the presence of saponins.

5.7 Test for Tannins (Gelatin Test)
Each extract was mixed with gelatin solution containing sodium chloride. Formation of a white precipitate indicated the presence of tannins.

5.8 Test for Anthraquinone Glycosides (Borntrager's Test)
The extract was treated with benzene followed by ammonia solution. Development of a pink to red colour in the ammoniacal layer indicated the presence of anthraquinone glycosides.

5.9 Test for Phlobatannins
Each extract was boiled with 1% hydrochloric acid. Formation of a red precipitate indicated the presence of phlobatannins.

5.10 Test for Phytosterols
The extract was treated using Liebermann–Burchard reagent. Development of a green or bluish-green colour confirmed the presence of phytosterols.

5.11 Test for Lignins
The extract was treated with phloroglucinol followed by concentrated hydrochloric acid. Development of a cherry-red colour indicated the presence of lignins.

5.12 Test for Quinones
A few drops of concentrated sulphuric acid were added to the extract. Formation of a red coloration indicated the presence of quinones.

5.13 Test for Anthocyanins
The extract was treated with dilute hydrochloric acid followed by ammonia solution. A change in colour from pink-red to bluish-green indicated the presence of anthocyanins.

5.14 Test for Coumarins
Each extract was treated with 10% sodium hydroxide solution. Development of a yellow fluorescence under UV light indicated the presence of coumarins.

6. Statistical Analysis
The present investigation involved preliminary qualitative phytochemical screening; therefore, the results were recorded based on the presence (+) or absence (−) of phytochemical constituents. Since the observations were qualitative in nature, no statistical analysis was performed.

Results
1. Physical Characteristics of Yellow Passion Fruits
A total of ten fresh yellow passion fruits (*Passifloraedulis f. flavicarpa*) were analyzed to determine their physical characteristics. The measurements recorded included total weight, length, diameterand the individual weights of pulp, seedsand seeds (both fresh and shade-dried). The average values are presented in Table 1.

Table 1: Physical characteristics of yellow passion fruits

Parameter	Average Value
Total weight of fresh fruit	64 g
Length of fresh fruit	10 cm
Diameter of fresh fruit	9.5 cm
Pulp and seeds weight	29 g
Pulp weight	17 g
Pulp and seeds weight	29 g
Pulp weight	17 g
Seed weight	12 g
Seed weight (fresh)	35 g
Seed weight (shade-dried)	14 g

During observation, the pulp colour was found to be yellow, while the seeds exhibited a bright yellow exocarp and a white endocarp. The seeds were black in colour, enclosed within the yellow pulp.

The results indicate that the seed constitutes a major portion of the fruit's total weight, accounting for more than half of the total mass. After shade drying, the seed weight reduced significantly due to the loss of moisture content, indicating high water retention capacity in the fresh state. Similar findings were reported in previous studies on *Passifloraedulis* varieties, where seed weight represented a significant proportion of total fruit mass.

The observed morphological characteristics such as fruit size, pulp colourand seed traits are consistent with descriptions of the Kaveri hybrid variety, suggesting that the fruit samples were well-developed and physiologically mature at the time of collection. The variation in seed and pulp proportions also indicates the potential of the seed as a valuable source of bioactive compounds, aligning with earlier reports on the phytochemical richness of passion fruit by-products.

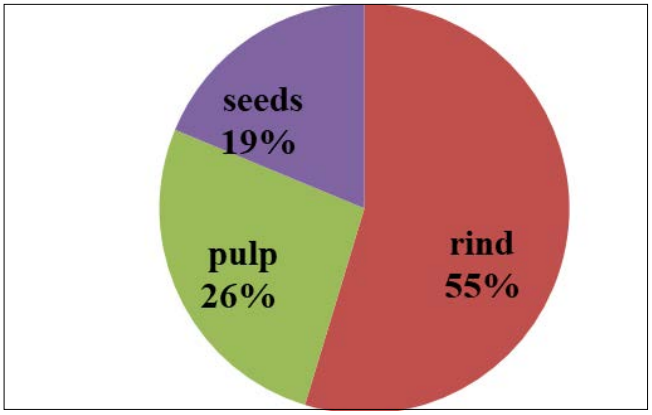

Fig 2: Contents of average whole passion fruit.

On average yellow passion fruit consists of approximately 55% seed, 26% pulp and 19% seeds by weight indicating that the seed constituents the major portion of the fruit.

Fig 3: Images of passion fruit, fresh seeds, dried seeds and seed powder.

The shade-dried yellow passion fruit seeds were powdered using a pestle and mortar. The resulting powder was used for the extraction process. Fruit seed extracts were obtained by the maceration method using three different solvents. After filtration, 200 ml of chloroform extract, 200 ml of methanol extractand 200 ml of distilled water extract were obtained. A total of three extracts were collected, which were subsequently subjected to preliminary phytochemical screening to detect specific bioactive compounds present in the extracts.

2. Qualitative Phytochemical Screening of Yellow Passion Fruit Seed Extracts
The qualitative phytochemical profile of *Passiflora edulis* Sims seed extracts prepared using chloroform, methanol, and distilled water is presented in Table 2. The phytochemical composition varied depending on the extraction solvent, indicating that solvent polarity influences the recovery of secondary metabolites.

Among the fourteen phytochemical groups investigated, terpenoids were detected in all three solvent extracts,

suggesting their widespread occurrence in yellow passion fruit seeds irrespective of solvent polarity. In contrast, steroids, anthraquinone glycosides, and phytosterols were detected exclusively in the chloroform extract, whereas these compounds were absent in the methanol and distilled water extracts.

No detectable levels of alkaloids, phenols, flavonoids, saponins, tannins, phlobatannins, lignins, quinones, anthocyanins, or coumarins were observed in any of the three extracts under the conditions employed in this preliminary qualitative screening.

Overall, the chloroform extract exhibited a comparatively broader phytochemical profile than the methanol and aqueous extracts.

Table 2: Qualitative phytochemical screening of *Passiflora edulis* Sims seed extracts.

Phytochemical	Chloroform Extract	Methanol Extract	Distilled Water Extract
Alkaloids	–	–	–
Phenols	–	–	–
Flavonoids	–	–	–
Terpenoids	+	+	+
Steroids	+	–	–
Saponins	–	–	–
Tannins	–	–	–
Anthraquinone Glycosides	+	–	–
Phlobatannins	–	–	–
Phytosterols	+	–	–
Lignins	–	–	–
Quinones	–	–	–
Anthocyanins	–	–	–
Coumarins	–	–	–

(–): Absent (+): Present

Discussion

The present investigation provides a preliminary qualitative assessment of phytochemicals present in yellow passion fruit (*Passiflora edulis* Sims) seed extracts prepared using solvents of different polarities. The results demonstrate that the extraction solvent markedly influenced the phytochemical profile obtained.

Terpenoids were detected in all three solvent extracts, indicating that these compounds are consistently extractable under the extraction conditions employed. Terpenoids are among the most widely distributed plant secondary metabolites and have been associated with antioxidant, antimicrobial, anti-inflammatory, and other biological activities. Their presence in all extracts suggests that yellow passion fruit seeds may contain terpenoid constituents that warrant further characterization through quantitative and chromatographic analyses.

Steroids, phytosterols, and anthraquinone glycosides were detected only in the chloroform extract. Chloroform is a relatively non-polar solvent and is generally more effective in extracting lipophilic constituents. The exclusive detection of these compounds in the chloroform extract is therefore consistent with their comparatively lower polarity and greater solubility in non-polar solvents. This finding suggests that chloroform extraction may be more suitable for recovering these classes of compounds from yellow passion fruit seeds.

In contrast, methanol and distilled water extracts did not show detectable levels of steroids, phytosterols, or anthraquinone glycosides. Although methanol is commonly used to extract a wide range of phytochemicals, the absence of these compounds in the present study may reflect their low concentration, limited extractability under the extraction conditions used, or the sensitivity of the qualitative tests employed. Further quantitative analyses using instrumental techniques such as HPLC or GC–MS would be required to confirm these observations.

Several phytochemical groups, including alkaloids, phenols, flavonoids, saponins, tannins, phlobatannins, lignins, quinones, anthocyanins, and coumarins, were not detected in any of the extracts. It should be noted that a negative result in qualitative screening does not necessarily indicate complete absence of these compounds in the seeds. Their concentrations may have been below the detection limits of the qualitative assays, or different extraction conditions may be required for their recovery. Therefore, these findings should be interpreted as preliminary observations rather than definitive evidence of absence.

The observed variation among solvent extracts highlights the importance of solvent selection during phytochemical investigations. Different solvents differ in their ability to dissolve specific groups of secondary metabolites, and the choice of solvent directly influences the phytochemical profile obtained. Consequently, the use of multiple solvents remains an effective strategy for the preliminary exploration of plant-derived bioactive compounds.

Overall, the present findings indicate that yellow passion fruit seeds possess detectable secondary metabolites, particularly terpenoids, steroids, phytosterols, and anthraquinone glycosides. As passion fruit seeds are commonly discarded during juice processing, their phytochemical potential supports the concept of valorizing this agro-industrial by-product for future nutraceutical, pharmaceutical, and functional food applications. Nevertheless, additional studies involving quantitative phytochemical estimation, chromatographic identification of individual compounds, and biological activity evaluation are necessary before practical applications can be established.

Conclusion

The present preliminary qualitative phytochemical investigation demonstrated that yellow passion fruit (*Passiflora edulis* Sims) seeds contain detectable secondary metabolites, with the phytochemical profile varying according to the extraction solvent. Terpenoids were present in chloroform, methanol, and distilled water extracts, whereas steroids, phytosterols, and anthraquinone glycosides were detected only in the chloroform extract. No detectable levels of alkaloids, phenols, flavonoids, saponins, tannins, phlobatannins, lignins, quinones, anthocyanins, or coumarins were observed under the conditions employed in this study.

These findings indicate that yellow passion fruit seeds represent a potentially valuable agro-industrial by-product containing bioactive constituents suitable for further investigation. Future research should focus on quantitative phytochemical analysis, chromatographic characterization, and evaluation of biological activities to better understand

the functional and pharmacological potential of these seed extracts.

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Conflicts of Interest
The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this manuscript.

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