Iqra Journal of Pharmacy
Vol: 01, No. 1 (2026) 38 – 44

Total Flavonoid Content in Cucumis sativus L.: A Comparative Analysis of Peel, Pulp, and Seed Hydroethanolic Extracts

Sara Naqvi[1]*, Hania Kauser[1], M. Talha[1], Javeria Shakeel[1], Noman Abid[1]

[1]Faculty of Pharmacy, Iqra University, Karachi, Pakistan

Submission Date: April 7, 2025 **Review completed:** August 6, 2025
Acceptance Date: August 8, 2025 **Publication Date:** January 01, 2026

Abstract: *Polyphenols are plant metabolites known for their antioxidant, anti-inflammatory, anti-cancer, and cardioprotective effects. Flavonoids, a major group of polyphenols, that is comprised of two aromatic rings linked by a three-carbon chain and are further classified into flavanols, flavones, isoflavones, and anthocyanins, these compounds support heart, brain, and gut health and are found in fruits, vegetables, and medicinal plants. Cucumber (Cucumis sativus L.), belonging to the cucurbitaceae family, is a hydrating, low-calorie fruit rich in phytochemicals such as flavonoids, lignans, and triterpenes. The present study was proposed to evaluate the qualitative and quantitative analysis of TFC of hydroethanolic extract of peel, pulp and seed of cucumber. The association between the content of flavonoids in different parts of cucumber. The acid-alkaline test was executed in all extracts. The total flavonoids content was carried out using aluminum chloride calorimetric method and noted by using the quercetin standard calibration curve. The result revealed that the pulp extracts of cucumber contained an abundant amount of total flavonoid contents (44.46 QE/g) as compared to peel and seed extract of cucumber contained 35.90 ± 1.45, and 36.01 ± 0.98 respectively. Our findings indicate that consuming cucumbers with their peels, which are rich in flavonoids, may provide enhanced health benefits compared to eating peeled cucumbers.*

Keywords: Cucumber, Polyphenols, total flavonoid content.

Introduction

Polyphenols are a significant group of secondary phyto metabolites known for antioxidant, anti-inflammatory, anti-cancer, and cardio protective effects (Saleem et al., 2022). They are widely distributed in the plants and are classified into flavonoids, phenolic acids, tannins, and other subclasses (Ahmad et al., 2021). Flavonoids, a major subclass of polyphenols, are characterized by a structure comprising of two aromatic rings linked by a three-carbon chain. Based on their chemical structure, flavonoids are further categorized into flavanols (e.g., quercetin), flavones (e.g., apigenin), isoflavones (e.g., genistein), and anthocyanins (e.g., cyanidin) (Subhan, Zeeshan, Rahman, & Yaseen, 2024). The flavonoid and their types are also enlisted in the

[1] Faculty of Pharmacy, Iqra University, Karachi, Pakistan
sara.naqvi@iqra.edu.pk

Fig 1. These bioactive compounds contribute to cardio protection, neuroprotection, and improved gut health (Naqvi, Rehman, Azhar, & Palla, 2024), and are abundantly present in fruits, vegetables, and medicinal (Dias, Pinto, & Silva, 2021).
Cucumber (Cucumis sativus L.), a member of the Cucurbitaceae family, is not only a hydrating and low-calorie food but also enriched in flavonoids, lignans, and triterpenes (Kaur & Sharma, 2022).

Cucumber exhibits potent antioxidant activity, scavenging free radicals and reducing oxidative stress linked to chronic diseases such as cardiovascular disorders and cancer (Nawaz & Shad, 2018). Clinical studies suggest its anti-diabetic potential, with extracts demonstrating blood glucose-lowering effects in animal models (Awote et al., 2030). Additionally, cucumber possesses, anti-inflammatory properties, beneficial for conditions like arthritis, wound-healing capabilities (Javid et al., 2024), antimicrobial activity against pathogens like E. coli and S. aureus (Al-Snafi, 2016), hepatoprotective and gastroprotective effects (Naqvi et al., 2024), and reduced liver damage and ulcer incidence in preclinical studies (Dimeji, Samson, Muiz, Ayoola, & Olufemi, 2021). This fruit is also considered as an emerging candidate for anticancer potential, though further research is needed to elucidate mechanisms (Pandey & Khan, 2021). The health benefits of cucumber are also enlisted in the Fig 2.

Figure 1: Flavonoid, classification and their sources.

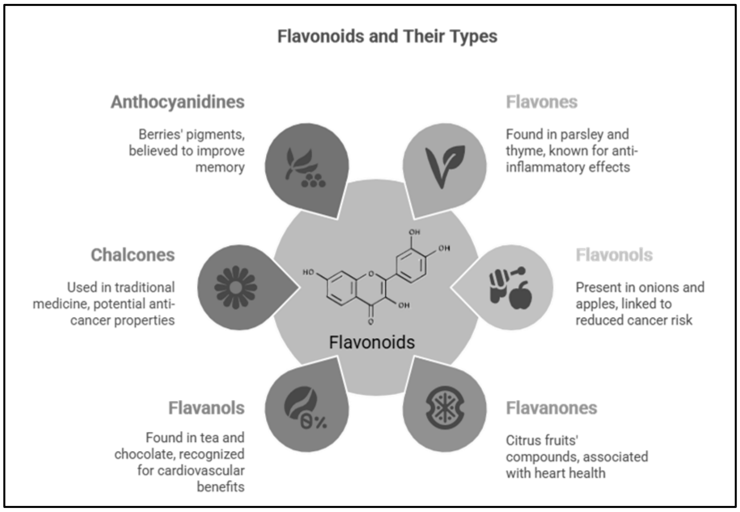
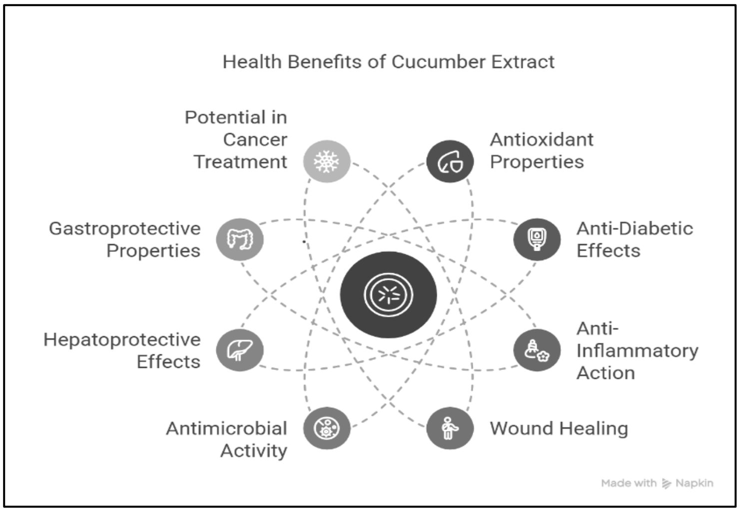


Figure 2: Health benefits of the Cucumber extracts.



This study aimed to quantify the total flavonoid content (TFC) in hydroethanolic extracts of Cucumis sativus L. peel, pulp, and seeds using quercetin as a standard, providing insights into their nutraceutical potential.

Methodology

Plant material

The ripe fruit samples of cucumber were procured from the local market of Karachi, Pakistan. Fruit sample (2 kg) was washed thoroughly to remove dirt and irrelevant material then cut into small pieces. The cucumbers were then manually separated into peel, pulp, and seeds using a sterilized knife. Each component was finely chopped to ensure uniform extraction.

Extract preparation

Each part of cucumber was extracted in a mixture of a solvent comprising of ethanol (70%), and distilled water (30%) for 8–10 days at room temperature. The contents were filtered through muslin cloth. All the filtrates were concentrated with a rotary evaporator under vacuum at 40 °C and the extracts were kept at -80 °C before analysis (Naqvi et al., 2024).

The acid-alkaline test

To check for flavonoids in all the cucumber extracts, an acid-alkaline test was done. 3 ml of each extract was mixed separately with a few drops of a 2% sodium hydroxide solution. When a yellow, cloudy substance showed up, it meant flavonoids were present. The precipitate was further tested by adding 0.5 mL concentrated HCl (hydrochloric acid). Disappearance of the yellow color confirmed flavonoids (Naqvi, Imam, Ali, Azhar, & Mahmood, 2020).

Quantitative Analysis
To figure out how much of the flavonoids were in the different cucumber extracts, we used the Aluminum chloride (AlCl3) colorimetric method. For each cucumber extract, we took 0.5 mL and mixed it with 1.5 mL of methanol, 0.1 mL of 1 M sodium acetate, and 0.1 mL of 10% aluminum chloride. Then, we added 2.8 mL of distilled water, mixed it all up, and let it incubate for 30 minutes. The procedure was carried out for each extract separately and measured the absorbance of each solution at a wavelength of 415 nm. To create a blank (which is basically a control), we did the same thing but used distilled water instead of AlCl3.The contents of total flavonoid were recorded using the quercetin standard (QE µg/g) calibration curve ($Y = 0.0174x + 0.0713$). The same procedure was repeated with all fruit samples (Naqvi et al., 2020).

Results

All of the cucumber extracts showed positive results for flavonoids as indicated by appearance of yellow precipitates which disappeared upon addition of HCl. Peel extract of cucumber exhibited the strongest reaction (+++), correlating with its high TFC, whereas seed extract of cucumber showed the weakest reaction (+), aligning with its low TFC as mentioned in Table 1. These findings are also in consistent in TFC testing, the pulp extract of cucumber showed the highest TFC 44.46 µg QE/g, whereas peel extract of cucumber showed the lowest concentration, 35.90 µg QE/g as mentioned in Table 1.

Table 1: Qualitative and quantitative evaluation of Cucumis sativus extracts

Part of Cucumber	TFC (µg QE/g dry weight)	Acid-Alkaline Test Result
Peel	35.90 ± 1.45	+++
Pulp (Inner Part)	44.46 ± 2.10	++
Seeds	36.01 ± 0.98	+

+ = Trace, ++ = Moderate, +++ = Highest

Discussion

Plants are considered as a cornucopia of phytoconstituents, and health promising effects of these medicinal plants are attributed to the presence of phytochemicals (Ogbuagu et al., 2022). These phytochemicals showed multitude of pharmacological action, leading to drug discovery from the medicinal plants (Alam et al., 2022). Numerous studies have established a direct correlation between flavonoid-rich diets and reduced risk of chronic diseases including cancer, diabetes, neurodegenerative disorders, and cardiovascular conditions. Our comprehensive investigation of different parts of cucumber through both qualitative (acid-alkaline test) and quantitative (AlCl3 colorimetric assay) analysis has yielded significant findings regarding their flavonoid composition.
Our quantitative analysis demonstrated that the pulp contained the highest TFC (44.46 ± 2.10 µg QE/g), followed by the peel (35,90 ± 1.45 µg QE/g) and seeds (36.01 ± 0.98 µg QE/g). This contrasts with previous studies that identified the peel as the primary flavonoid reservoir in cucumbers (Nawaz et al., 2018), suggesting that extraction methodology and fruit maturity significantly influence flavonoid distribution. It is worthy to note that variations in solvent and method extraction greatly affect the presence and composition of the secondary metabolite (Acquavia et al., 2021).

The acid-alkaline test confirmed the presence of flavonoids in all parts, with the peel exhibiting the strongest reaction (+++), indicating a high concentration of free flavonoid aglycones. The pulp, despite having the highest TFC, showed a moderate reaction (++), likely due to the predominance of glycosylated flavonoids, which require hydrolysis for detection (Markham, 1982). Seeds displayed the weakest reaction (+), aligning with their lower TFC, possibly because their flavonoids are bound to lipids, reducing extractability in hydroethanolic solvents (Al-Snafi, 2016).

The high flavonoid content suggests that cucumber pulp is an underutilized source of bioavailable flavonoids, particularly glycosides, which may offer superior systemic antioxidant effects when consumed These findings challenge the common practice of discarding cucumber pulp in food processing, highlighting its potential for functional food formulations. The peel's strong acid-alkaline reactivity suggests it is rich in free aglycones, which are highly bioactive and may be more effective in topical applications (e.g., wound healing, anti-inflammatory creams). However, its slightly lower TFC than the pulp indicates that traditional peel-focused extraction methods may overlook the pulp's nutritional value. Though seeds had the lowest TFC, they contain unique compounds like cucurbitacin, which exhibit anti-cancer and hepatoprotective properties (Pandey & Khan, 2021). Future studies should explore non-polar solvents (e.g., hexane, acetone) to better recover seed-specific flavonoids.

Emerging evidence suggests that cucumber is part of low FODMAP (Fermentable Oligosaccharide, Disaccharides, Monosaccharides and Polyols) diet, its flavonoids may play a beneficial role in managing irritable bowel syndrome (IBS) and inflammatory bowel disease (IBD), owing to their anti-inflammatory, antioxidant, and microbiota-modulating properties (Gibson & Shepherd, 2010). Their anti-inflammatory action via NF-κB inhibition alleviates IBD symptoms in preclinical models. The peel's aglycones (35.90 μg QE/g) protect intestinal barriers by reducing oxidative stress, crucial for IBS management. Seed-derived vitexin (36.01 μg QE/g) shows promise in reducing colitis severity by 40-50% in rodent studies. These same compounds systemically improve vascular health, with peel flavonoids reducing LDL oxidation by 60% and pulp glycosides enhancing endothelial function. Dual modulation of inflammation positions cucumber as a multitarget functional food for metabolic-gut axis disorders (Wibowo & Anita, 2021).

Cucumber has many pharmacological benefits like as nutrient contains thiamin, riboflavin, niacin, vitamin B-6, and vitamin A. In cosmetics It is use to soothe down irritation, redness and inflammation associated with summertime woes like sun burns and insect bites. The antioxidant assays showed that three varieties of cucumber contain the significant antioxidant activity. Cucumber plays vital role in preventing various diseases such as inflammation, bacterial infection, lipid peroxidation, fever, constipation, in cardiovascular health, gout and arthritis pain by lowering the uric acid levels and it is also giving benefit in pregnancy etc. (Akhtar, Ahmad, Jameela, Ashfaque, & Begum, 2020).

Conclusion

This study demonstrates that *Cucumis sativus* L. as a rich source of flavonoids, particularly in its pulp and peel, underscoring its potential as a valuable nutraceutical. The findings provide a compelling rationale for reevaluating cucumber's role in dietary strategies aimed at preventing chronic diseases. Future research should prioritize optimizing extraction methods and investigating *in vivo* bioavailability to unlock the full therapeutic potential of cucumber-derived flavonoids.

Conflict of Interest

The authors declare no conflict of interest related to the publication of this study.

Acknowledgement

The authors extend their sincere gratitude to the Prof. Dr. Muhammad Imran (Head of Department, Iqra University) and Prof. Dr. Saira Azhar (Dean Faculty of Pharmacy, Iqra University), for providing the laboratory facilities and technical assistance necessary to carry out this research.

References

Acquavia, M. A., Pascale, R., Foti, L., Carlucci, G., Scrano, L., Martelli, G., . . . Lelario, F. (2021). Analytical methods for extraction and identification of primary and secondary metabolites of apple (Malus domestica) fruits: A review. Separations, 8(7), 91.

Ahmad, A., Ahmad, V., Zamzami, M. A., Chaudhary, H., Baothman, O. A., Hosawi, S., Khan, M. J. (2021). Introduction and classification of natural polyphenols Polyphenols-Based Nanotherapeutics for Cancer Management (pp. 1-16): Springer.

Akhtar, P., Ahmad, I., Jameela, A., Ashfaque, M., & Begum, Z. (2020). Energizing effectiveness of cucumber (Khayarain) for health. A review article. Journal of Emerging Technologies and Innovative Research, 7(11), 906-917.

Al-Snafi, A. E. (2016). Medicinal plants with antimicrobial activities (part 2): Plant based review. Sch Acad J Pharm, 5(6), 208-239.

Alam, S., Sarker, M. M. R., Sultana, T. N., Chowdhury, M. N. R., Rashid, M. A., Chaity, N. I., . . . Khan, S. A. (2022). Antidiabetic phytochemicals from medicinal plants: prospective candidates for new drug discovery and development. Frontiers in endocrinology, 13, 800714.

Awote, O., Adeyemo, A., Ogunrinola, O., Ogunyinka, B., Adenekan, I., & Kayode, B. (2030). Ameliorative Potential of the Polyphenolic Compounds in Cucumis sativus (Linn.) Fruit Pulp Extract on Streptozotocin-induced Diabetes in Male Wistar Rats. Zeugma Biological Science, 6(2), 41-71.

Dias, M. C., Pinto, D. C., & Silva, A. M. (2021). Plant flavonoids: Chemical characteristics and biological activity. Molecules, 26(17), 5377.

Dimeji, I. Y., Samson, A. O., Muiz, M. A., Ayoola, A. M., & Olufemi, M. A. (2021). Hypolipidemic, Antioxidant, and Hepatoprotective Effects of Cucumber (Cucumis Sativus L.)-Supplemented Diet in Both Sexes of Sprague-Dawley Rats. Nigerian Journal of Experimental and Clinical Biosciences, 9(2), 82-88.

Gibson, P. R., & Shepherd, S. J. (2010). Evidence-based dietary management of functional gastrointestinal symptoms: the FODMAP approach. Journal of gastroenterology and hepatology, 25(2), 252-258.

Javid, H., Fatima, U., Rukhsar, A., Hussain, S., Bibi, S., Bodlah, M. A., . . . Sharif, A. (2024). Phytochemical, Nutritional and Medicinal Profile of Cucumis sativus L.(Cucumber). Food Science and Engineering, 358-377.

Kaur, M., & Sharma, P. (2022). Recent advances in cucumber (Cucumis sativus L.). The Journal of Horticultural Science and Biotechnology, 97(1), 3-23.

Naqvi, s., imam, s., ali, f. R., azhar, i., & mahmood, z. A. (2020). Total flavonoids content of some seasonal fruits and their beneficial effects on cardiovascular disease: a cross-sectional study. Asian J Pharm Clin Res, 13(7), 123-126.

Naqvi, S., Rehman, N. U., Azhar, I., & Palla, A. (2024). Unraveling the multi-faceted role of Rosmarinus officinalis L.(rosemary) and diosmetin in managing gut motility. Journal of Ethnopharmacology, 332, 118395.

Nawaz, H., & Shad, M. A. (2018). Phytochemical Composition and Antioxidant Potential. Brassica Germplasm: Characterization, Breeding and Utilization, 7.

Ogbuagu, O. O., Mbata, A. O., Balogun, O. D., Oladapo, O., Ojo, O. O., & Muonde, M. (2022). Novel phytochemicals in traditional medicine: Isolation and pharmacological profiling of bioactive compounds. International Journal of Medical and All Body Health Research, 3(1), 63-71.

Pandey, P., & Khan, F. (2021). A mechanistic review of the anticancer potential of hesperidin, a natural flavonoid from citrus fruits. Nutrition Research, 92, 21-31.

Saleem, A., Akhtar, M. F., Sharif, A., Akhtar, B., Siddique, R., Ashraf, G. M., . . . Alharthy, S. A. (2022). Anticancer, cardio-protective and anti-inflammatory potential of natural-sources-derived phenolic acids. Molecules, 27(21), 7286.

Subhan, S., Zeeshan, M., Rahman, A. U., & Yaseen, M. (2024). Fundamentals of polyphenols: nomenclature, classification and properties. Science and Engineering of Polyphenols: Fundamentals and Industrial Scale Applications, 1-36.

Wibowo, M. A., & Anita, D. C. (2021). Cucumber juice treatment to the decrease of systolic and diastolic blood pressure. age, 65(70), 4.