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Comparative Phytochemical Screening and Antioxidant Activity of Aqueous Seed Extracts of Prunus armeniaca and Carica papaya

Nazneen Zehra

naznynz@gmail.com

University of Karachi

Research Article

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Abstract

The use of medicinal plant seeds in traditional therapies is increasing; however, limited data exist regarding their phytochemical composition and antioxidant potential. This study aimed to comparatively evaluate the phytochemical constituents and in vitro antioxidant activity of aqueous seed extracts of *Prunus armeniaca* (PASE) and *Carica papaya* (CPE). Standard qualitative phytochemical screening was performed to detect major secondary metabolites. Antioxidant activity was assessed using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging assay and a reducing power assay. Both extracts showed the presence of alkaloids, flavonoids, tannins, saponins, coumarins, terpenoids, steroids and glycosides. In the DPPH assay, both extracts exhibited concentration-dependent scavenging activity (10–50 µg/mL), with CPE demonstrating higher percentage inhibition than PASE at corresponding concentrations. Similarly, reducing power increased with concentration for both extracts, and CPE showed higher absorbance values than PASE at higher concentrations. These findings indicate that both seed extracts possess measurable antioxidant potential in vitro, with *C. papaya* seeds exhibiting comparatively stronger activity under the conditions tested, supporting their traditional use and warranting further quantitative phytochemical profiling and safety- and mechanism-focused investigations.

1. Introduction

Medicinal plants are an important source of biologically active compounds with therapeutic potential due to their rich phytochemical profiles and antioxidant capabilities.[1] Phytochemicals such as flavonoids, phenolics, tannins, and alkaloids have been widely reported to mitigate oxidative stress by scavenging free radicals and reducing reactive oxygen species (ROS), thereby contributing to health benefits in chronic diseases.[2] Prunus armeniaca L. (apricot) seeds have been shown to contain diverse bioactive compounds linked to antioxidant and other beneficial properties, although research on their medicinal potential remains limited.[3] Carica papaya L. (papaya) seeds are traditionally recognized for their phytochemical richness and potential antioxidant effects, yet seed-specific antioxidant studies are relatively scarce compared with other plant parts.[4] The rising scientific interest in plant seeds as sources of natural antioxidants reflects their role in countering oxidative stress and supporting human health.[5] Therefore, this study aimed to comparatively analyse the phytochemical profiles and antioxidant activities of Prunus armeniaca and Carica papaya seeds to assess their potential as natural sources of therapeutic antioxidants.

2. Materials and Methods

2.1 Plant material collection

Fresh fruits of *Prunus armeniaca* L. and *Carica papaya* L. were procured from a local market in Karachi, Pakistan. The plant materials were identified based on morphological characteristics using standard

botanical and pharmacognostic references, [6, 7]. In addition, Plant identification was confirmed at the Department of Botany, University of Karachi, Pakistan; however, voucher specimens were not prepared or deposited. No specific cultivar (cv.) or variety (var.) information was available for the samples used in this study, as they were obtained from a commercial source.

2.2 Preparation of aqueous seed extracts

2.2.1 *Prunus armeniaca* seed extract (PASE)

Apricot seeds were washed, shade-dried, and ground into fine powder. Twenty grams of seed powder were mixed with 200 mL of distilled water and agitated on a rotary shaker at 200 rpm for 15 min, followed by incubation at room temperature for 24 h. The mixture was filtered through Whatman No. 1 filter paper, and the filtrate was oven-dried at 40°C to obtain a concentrated extract. The dried extract was stored and reconstituted in distilled water to the required concentrations prior to analysis.[8]

2.2.2 *Carica papaya* seed extract (CPE)

Papaya seeds were isolated, washed, sun-dried, and finely ground. Forty grams of seed powder were mixed with 500 mL of distilled water and boiled for 30 min. The mixture was filtered using Whatman No. 1 filter paper and allowed to cool for 4 h before oven drying at 40°C. The extraction process was repeated four times, pooled, and stored in airtight containers at 4°C. The dried extract was reconstituted to the desired concentrations prior to analysis. [9]

2.3 Qualitative phytochemical screening

Qualitative phytochemical screening was carried out to detect major secondary metabolites, including flavonoids, tannins, saponins, coumarins, steroids, terpenoids, glycosides, and alkaloids, using standard chemical methods. Flavonoids were identified using the magnesium–hydrochloric acid test, while tannins were detected using ferric chloride reagent.[10] Saponins were determined by the froth formation test, whereas coumarins were identified using chloroform and sodium hydroxide.[11, 6] Steroids and terpenoids were detected using chloroform and concentrated sulphuric acid.[6, 11] Glycosides were identified using Fehling's solution following acid hydrolysis, and alkaloids were detected using Dragendorff's reagent. [11]

2.4 DPPH free radical scavenging assay

Antioxidant activity was assessed using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging assay. A 0.1 mM DPPH solution was prepared in methanol and mixed with extract solutions at concentrations of 10–50 µg/mL. After incubation in the dark at room temperature for 30 min, absorbance was measured at 517 nm. A blank without extract was used for comparison, and ascorbic acid served as the reference standard. Percentage scavenging activity was calculated as described previously. [12, 13] IC50 values were estimated by linear interpolation from concentration–response

curves using the two highest tested concentrations, as 50% inhibition was not achieved within the experimental concentration range.

2.5 Reducing power assay

The reducing power of the extracts was determined using the potassium ferricyanide reduction method as described by Gulcin and Alwasel.[14] Absorbance was measured at 700 nm, with higher absorbance indicating greater reducing power. Ascorbic acid was used as the reference standard.

2.6 Statistical analysis

All experiments were performed in technical triplicate, and results are presented as mean ± standard deviation (SD). Because only one extract preparation per plant species was analysed, the triplicate measurements reflect assay repeatability rather than biological variability. Therefore, the analysis was descriptive rather than inferential, and differences between extracts are reported as observed trends under the tested conditions without claims of statistical significance.[15]

3. Results

3.1 Phytochemical composition of *Prunus armeniaca* and *Carica papaya* seed extracts

Table 1
Qualitative phytochemical screening of aqueous seed extracts

Phytochemical constituents	PASE	CPE
Alkaloids	+++	+++
Flavonoids	++	+++
Tannins	+	+++
Saponins	++	+
Coumarins	+	+
Steroids	+	+
Terpenoids	+	++
Glycosides	+++	++

+, mild presence; ++, moderate presence; +++, abundant presence.

Qualitative phytochemical screening revealed the presence of multiple bioactive constituents in both seed extracts (Table 1). *Prunus armeniaca* seed extract (PASE) demonstrated abundant alkaloids and glycosides, with moderate levels of flavonoids and saponins, while coumarins, terpenoids, steroids, and

tannins were detected in mild amounts. In contrast, *Carica papaya* seed extract (CPE) showed abundant alkaloids, flavonoids, and tannins, moderate levels of glycosides and terpenoids, and mild presence of saponins, coumarins, and steroids.

3.2 DPPH free radical scavenging activity

Table 2
DPPH radical scavenging activity of seed extracts

Concentration (µg/mL)	Ascorbic acid (%)	PASE (%)	CPE (%)
10	31.41	13.61	15.22
20	37.70	20.06	23.29
30	45.90	23.74	29.29
40	50.81	32.02	41.96
50	54.09	36.25	44.41
IC_{50} (µg/mL)	≈ 38–40	≈ 82.5	≈ 72.8

IC_{50} values were estimated by linear interpolation using the two highest tested concentrations, as 50% inhibition was not achieved within the experimental concentration range for the seed extracts.

The DPPH free radical scavenging activity of PASE and CPE increased in a concentration-dependent manner over the tested range of 10–50 µg/mL (Table 2). Ascorbic acid showed the highest scavenging activity at all concentrations. At corresponding concentrations, CPE exhibited higher percentage inhibition values than PASE. The estimated IC_{50} values were approximately 82.5 µg/mL for *Prunus armeniaca* seed extract and 72.8 µg/mL for *Carica papaya* seed extract, while ascorbic acid showed a lower IC_{50} value of approximately 38–40 µg/mL.

3.3 Reducing power activity

Table 3
Reducing power of seed extracts (mean ± SD, n = 3)

Concentration (µg/mL)	Ascorbic acid (OD)	PASE (OD)	CPE (OD)
10	0.077 ± 0.01	0.034 ± 0.01	0.028 ± 0.001
20	0.090 ± 0.006	0.042 ± 0.014	0.049 ± 0.01
30	0.131 ± 0.02	0.088 ± 0.01	0.070 ± 0.01
40	0.234 ± 0.01	0.117 ± 0.03	0.150 ± 0.005
50	0.300 ± 0.02	0.190 ± 0.09	0.220 ± 0.02

Values are expressed as mean ± standard deviation (SD).

The reducing power of both seed extracts increased progressively with rising concentration, indicating enhanced electron-donating capacity (Table 3). Ascorbic acid showed the highest reducing activity across all concentrations. Between the extracts, CPE consistently demonstrated higher absorbance values than PASE at higher concentrations.

4. Discussion

The qualitative phytochemical screening of *Prunus armeniaca* and *Carica papaya* seed extracts demonstrated the presence of diverse secondary metabolites, supporting their traditional use and potential biological relevance. Both extracts contained alkaloids, flavonoids, tannins, saponins, glycosides, and terpenoids, although the relative abundance differed between species. Such compositional variability is expected, as phytochemical profiles are influenced by plant species, seed matrix, extraction solvent, and environmental factors.[1]

The presence of tannins in both extracts is notable, as tannins have been reported to exert antimicrobial effects through protein precipitation and membrane destabilisation, which may impair microbial enzyme activity and permeability rather than directly “killing” pathogens.[16] Alkaloids, detected abundantly in both extracts, are recognised for a broad range of pharmacological properties, including antimicrobial, antiviral, and antiparasitic activities. However, it is important to note that while quinine is a well-known antimalarial alkaloid, its presence cannot be inferred from general alkaloid detection alone, and specific compound identification would be required to support such claims. [17, 18]

Flavonoids, which were moderately to abundantly present, are widely implicated in antioxidant and antibacterial activities due to their capacity to donate electrons, chelate metal ions, and modulate redox-sensitive signalling pathways.[19] Similarly, saponins, although detected at lower levels, are known to exhibit both beneficial and adverse biological effects depending on concentration and structure, including immunomodulatory, cholesterol-lowering, and membrane-active properties.[20, 21] Glycosides identified in the extracts may further contribute to biological activity, particularly where flavonoid glycosides are involved, although functional effects are highly dependent on aglycone structure and bioavailability.[22, 23]

The antioxidant activity assessed using the DPPH radical scavenging assay revealed a clear concentration-dependent increase in percentage inhibition for both seed extracts. Ascorbic acid exhibited the highest radical scavenging activity across all concentrations, reflecting its role as a potent reference antioxidant. Among the extracts, *C. papaya* seed extract consistently demonstrated higher DPPH scavenging activity than *P. armeniaca*, suggesting comparatively greater free radical neutralisation capacity. This difference may reflect the higher relative abundance of flavonoids and tannins in papaya seeds observed in the phytochemical screening, as these classes are strongly associated with hydrogen-donating and electron-transfer mechanisms.[1]

It is important to note that the DPPH assay measures a single, non-physiological radical system and primarily reflects hydrogen-donating ability rather than comprehensive antioxidant capacity. Therefore, while the observed dose-dependent response supports the presence of antioxidant constituents, these findings should be interpreted as indicative rather than definitive of in vivo antioxidant efficacy. [24, 25]

Consistent with the DPPH findings, the reducing power assay demonstrated increasing absorbance with rising extract concentration, indicating enhanced electron-donating capacity. The higher reducing power observed for *C. papaya* seed extract at elevated concentrations further supports its stronger redox-modulating potential relative to *P. armeniaca*. Reducing power assays are considered complementary to radical scavenging assays, as they reflect the ability of phytochemicals to act as reductants and terminate oxidative chain reactions. [26, 23]

Collectively, the results suggest that both seed extracts possess measurable antioxidant activity that increases with concentration, with *C. papaya* seeds exhibiting comparatively greater activity across assays. However, antioxidant activity alone does not equate to therapeutic efficacy, and the presence of bioactive phytochemicals also raises considerations regarding safety, bioavailability, and potential toxicity. These aspects warrant further investigation using quantitative phytochemical profiling and biological models to better define benefit–risk relationships.

5. Conclusion

The present study demonstrates that aqueous seed extracts of *Prunus armeniaca* and *Carica papaya* possess diverse phytochemical profiles, including alkaloids, flavonoids, tannins, saponins, glycosides, and terpenoids, supporting their traditional medicinal relevance. Both extracts exhibited clear concentration-dependent antioxidant activity as evidenced by DPPH free radical scavenging and reducing power assays, indicating their capacity to modulate redox processes in vitro. Comparatively, *C. papaya* seed extract showed higher antioxidant activity across both assays, which may be related to differences in the relative abundance of flavonoids and tannins identified during phytochemical screening. The consistency of trends across complementary assays strengthens the reliability of these findings. However, as the assays employed assess specific in vitro mechanisms, the results should be interpreted cautiously and cannot be directly extrapolated to biological efficacy. Overall, this study contributes comparative seed-focused evidence to the existing literature and highlights the need for further quantitative, mechanistic, and safety-oriented investigations to better define the nutraceutical potential of these plant seeds.

Declarations

Ethics approval

Not applicable. This study did not involve human participants, human data, animals, or animal-derived biological materials.

Competing interests

The author declares no competing financial or non-financial interests.

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Author Contribution

N.Z. conceived and designed the study, performed the experiments, analysed and interpreted the data and wrote, reviewed, and revised the manuscript.

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Data Availability

The data generated and analysed during this study are included within this published article. Additional raw data supporting the findings are available from the corresponding author on reasonable request.

References

1. Muscolo A, Oteri M, Talarico G, Rende MO, Stress. The Role of Antioxidant Phytochemicals in the Prevention and Treatment of Diseases. Int J Mol Sci. 2024;25:3264. https://doi.org/10.3390/ijms25063264.
2. Chandimali N, Bak SG, Park EH, Lim HJ, Won YS, Kim EK, Park SI, Lee SJ. Free Radicals and Their Impact on Health and Antioxidant Defenses: A Review. Cell Death Discovery. 2025;11:19. https://doi.org/10.1038/s41420-024-02278-8.
3. Sharma S, Satpathy G, Gupta R, Nutritional. Phytochemical, Antioxidant and Antimicrobial Activity of Prunus armeniaca. J Pharmacognosy Phytochemistry. 2014;3:23–8.
4. Kong YR, Jong YX, Balakrishnan M, Bok ZK, Weng JKK, Tay KC, Goh BH, Ong YS, Chan KG, Lee LH, Khaw K. Y. Beneficial Role of Carica papaya Extracts and Phytochemicals on Oxidative Stress and Related Diseases: A Mini Review. Biology. 2021;10:287. https://doi.org/10.3390/biology10040287.

5. Rahaman MM, Hossain R, Herrera-Bravo J, Islam MT, Atolani O, Adeyemi OS, Owolodun OA, Kambizi L, Daştan SD, Calina D, Sharifi-Rad J. Natural Antioxidants from Fruits, Seeds and Foods and Associated Health Benefits: An Update. Food Sci Nutr. 2023;11:1657–70. https://doi.org/10.1002/fsn3.3217.
6. Trease GE, Evans WC, Pharmacognosy. 13th ed.; Baillière Tindall: London, 1989.
7. Sofowora A. Medicinal Plants and Traditional Medicine in Africa. 3rd ed. Spectrum Books: Ibadan,; 2008.
8. Abdulhay H. Insecticidal Activity of Aqueous and Methanol Extracts of Apricot Prunus armeniaca L. Kernels in the Control of Tribolium confusum. Al-Mustansiriyah J Sci. 2012;23(6):1–18.
9. Dada FA, Nzewuji FO, Esan AM, Oyeleye SI, Adegbola VB. Phytochemical and Antioxidant Analysis of Aqueous Extracts of Unripe Pawpaw (Carica papaya Linn.) Fruit Peel and Seed. Int J Res Rural Allied Sci. 2016;27(3):68–71.
10. Sabri FZ, Belarbi M, Sabri S, Muneer A. Phytochemical Screening and Identification of Some Compounds from Mallow. J Nat Prod Plant Resour. 2012;2:512–6.
11. Oluwakayode O, Obi G, Ogwuche CE, Elemike EE, Oderinlo Y. Phytochemical Screening, Antioxidant and Antimicrobial Activities of Senna occidentalis Leaves Extract. Clin Phytoscience. 2015;1:6. https://doi.org/10.1186/s40816-015-0007-y.
12. Brand-Williams W, Cuvelier ME, Berset C. Use of a Free Radical Method to Evaluate Antioxidant Activity. LWT - Food Sci Technol. 1995;28(1):25–30. https://doi.org/10.1016/S0023-6438(95)80008-5.
13. Larrauri JA, Sánchez-Moreno C, Saura-Calixto F. Effect of Temperature on the Free Radical Scavenging Capacity of Extracts from Red and White Grape Pomace Peels. J Agric Food Chem. 1998;46:2694–7.
14. Gülçin İ, Alwasel SH. Fe3+-Reducing Power as the Most Common Assay for Understanding the Biological Functions of Antioxidants. Processes. 2025;13:1296. https://doi.org/10.3390/pr13051296.
15. Field AP. Discovering Statistics Using IBM SPSS Statistics. 5th ed. Newbury Park: Sage; 2018.
16. Dong G, Liu H, Yu X, Zhang X, Lu H, Zhou T, Cao J. Antimicrobial and Anti-Biofilm Activity of Tannic Acid against Staphylococcus aureus. Nat Prod Res. 2018;32(18):2225–8. https://doi.org/10.1080/14786419.2017.1366485.
17. Cushnie TP, Cushnie B, Lamb AJ, Alkaloids. An Overview of Their Antibacterial, Antibiotic-Enhancing and Antivirulence Activities. Int J Antimicrob Agents. 2014;44:377–86. https://doi.org/10.1016/j.ijantimicag.2014.06.001.
18. Habibi P, Shi Y, Grossi-de-Sa MF, Khan I. Plants as Sources of Natural and Recombinant Antimalaria Agents. Mol Biotechnol. 2022;64:1177–97. https://doi.org/10.1007/s12033-022-00499-9.
19. Jomova K, Alomar SY, Valko R, Liska J, Nepovimova E, Kuca K, Valko M. Flavonoids and Their Role in Oxidative Stress, Inflammation, and Human Diseases. Chemical-Biological Interact. 2025;413:111489. https://doi.org/10.1016/j.cbi.2025.111489.

20. Podolak I, Galanty A, Sobolewska D. Saponins as Cytotoxic Agents: A Review. Phytochem Rev. 2010;9:425–74. https://doi.org/10.1007/s11101-010-9183-z.
21. Moses T, Papadopoulou KK, Osbourn A. Metabolic and Functional Diversity of Saponins, Biosynthetic Intermediates and Semi-Synthetic Derivatives. Crit Rev Biochem Mol Biol. 2014;49:439–62. https://doi.org/10.3109/10409238.2014.953628.
22. Xiao J, Capanoglu E, Jassbi AR, Miron A. The Paradox of Natural Flavonoid C-Glycosides and Health Benefits. Biotechnol Adv. 2014;32:114–32. https://doi.org/10.1016/j.biotechadv.2014.11.002.
23. Myhrstad MCW, Wolk A, Antioxidants, Phytochemicals, -. Food Nutr Res. 2023;67:10324. https://doi.org/10.29219/fnr.v67.10324. A Scoping Review for Nordic Nutrition Recommendations 2023.
24. Kedare SB, Singh RP. Genesis and Development of DPPH Method of Antioxidant Assay. J Food Sci Technol. 2011;48:412–22. https://doi.org/10.1007/s13197-011-0251-1.
25. Prior RL, Wu X, Schaich K. Standardized Methods for the Determination of Antioxidant Capacity and Phenolics in Foods and Dietary Supplements. J Agric Food Chem. 2005;53:4290–302. https://doi.org/10.1021/jf0502698.
26. Oyaizu M. Studies on Products of Browning Reaction Prepared from Glucosamine. Japanese J Nutr. 1986;44:307–15.