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CYTOTOXICITY EFFECTS OF ETHANOLIC EXTRACT OF PUNICA GRANATUM VAR. PLENIFLORA ON MCF-7 COMPARED WITH L929 CELLS

Gavanji S.[1], Bakhtari A.[2], Baghshahi H.[3]*, Badripour N.[3], Hamami Chamgordani Z.[4]

[1] Department of Plant Biotechnology, Medicinal Plants Research Centre, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

[2] Department of Reproductive Biology, School of Advanced Medical Sciences and Technologies, Shiraz University of Medical Sciences, Shiraz, Iran

[3] Barij Essence Medicinal Plants Research Center, Kashan, Iran

[4] Department of Adult Health Nursing, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran

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Abstract

Breast cancer is the most common type of cancer and has the highest mortality rate in women. Most of the methods used in cancer therapy have significant side effects. In recent years, the use of medicinal plants and products derived from them to prevent, treat and also manage the side effects of cancer has been considered. Pomegranates include a variety of phytochemical and phenolic substances.

This study was aimed to investigate the impact of pomegranate flower ethanolic extract on breast cancer cells (human breast cancer cell line). Initially, ethanolic extracts of P. granatum flowers were extracted from its dried powders. Using the 3-(4, 5 dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide test, the cytotoxic effects of the ethanolic extract of pomegranate flowers were evaluated in human breast cancer cell line compared with normal mouse fibroblast cells.

According to our findings, Punica granatum ethanolic extracts are less toxic to normal cells compared to human breast cancer cell line. Consequently, the minimum and maximum lethal concentrations of the P. granatum flower in normal cells were identified to be 150 and 450 µg/ml, whereas the minimum and maximum lethal concentrations were determined to be 700 and 1000 µg/ml in human breast cancer cell line.

The present study showed that pomegranate flower has anti-breast cancer potential. This potential benefit can be further examined in future research.

Keywords: *cancer, cytotoxicity, herbal medicine, pomegranate, traditional medicine.*

Introduction

Cancer accounts for one out of every six fatalities worldwide, making it the second most prevalent cause of death in human history [*Sharma A et al., 2023*]. The prevalence of chronic non-communicable diseases, such as cancer, is predicted to rise in the future decades as a result of an increase in life expectancy and the management of infectious and transmissible diseases [*Barrios C, 2022*].

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Address for Correspondence:

Hojjat Baghshahi
Barij Essence Medicinal Plants Research Center
Marzdaran Street, between Ariafar and Sarsabz, No 78 Kashan 379519116, Iran
Tel.: +989159031196
E-mail: Baghshahi_h1989@yahoo.com

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The primary factor in the progression of tumors in various body organs is the uncontrolled growth of specific body cells [*Grimm D et al., 2022*]. Genetic alterations, gene mutations, DNA damage, or alterations in the genetic sequence induced by carcinogens are the most common causes of tumors [*Sharma A et al., 2023*].

Breast cancer is the most frequent malignancy in the world, with 2.2 million recent cases and 685,000 deaths in 2020, and this cancer is the most common malignancy worldwide [*de Ligt et K et al., 2023*]. The death rate from breast cancer has increased in Asian, African, and Latin American countries [*Houghton S, Hankinson S, 2021*].

Breast-conserving therapy or mastectomy are two types of breast surgery. Adjuvant and neoadjuvant therapy, endocrine therapy, radiation, biological and targeted medicines, and immunotherapy are examples of non-surgical treatments for breast cancer [*Moo T et al., 2018; Debien V et al., 2023*]. Chemotherapy and radiation are routinely used in addition to surgery to treat all breast cancer. Since radiation exposure to the heart and lungs can have significant effects, it should be maintained to a minimum [*Burguin A et al., 2021*]. The development of multiple drug resistance and unexpected chemical reactions are chemotherapy side effects. These detrimental effects include bleeding, discomfort, ulcers in the mouth, hair loss, fever, and appetite loss [*Satapathy S et al., 2023*]. Surgery may also need radiotherapy and chemotherapy. The altered architecture of the breast, which increases the asymmetry of the breast, makes future interpretations much more challenging. There are long-lasting detrimental effects on the health and life of breast cancer patients, nevertheless advances in the discovery of drugs and a decline in mortality [*Lovelace D et al., 2019*].

A potential therapeutic strategy is the use of certain plants and the compounds produced from them as anti-cancer agents [*Baci G et al., 2023; Hashem S et al., 2022*]. It should be emphasized that, in contrast to normal individuals, patients who have successfully treated breast cancer may have anxiety, sadness, fear of illness recurrence, sexual dysfunction [*Toohey K et al., 2023*]. There is evidence that some herbal medications improve quality of life and side effects of chemotherapy and radiation therapy in cancer patients [*Dehghan M et al., 2022; Wang K et al., 2022*]. They can also help reduce the economic burden of managing treatment [*Han G et al., 2022*].

Various pomegranate parts, including seeds, peels, juice, and leaves, constitute a rich source of physiologically active substances. Pomegranate antioxidants are essential in the management of several disorders. This plant has therapeutic properties for cancer, endocrine disorders, oral cavity disorders, cardiovascular issues, diabetes, and cardiovascular difficulties [*Eghbali S et al., 2021; Marra F et al., 2022*]. Pomegranate is rich in phytochemical compounds, such as anthocyanins, punicalagin, tannins, hydrolysable tannins, ellagitannins, and punicic acid. This plant can be used to prevent the poisoning of heart cells caused by the adverse effects of many anticancer medications [*Koss-Mikołajczyk I et al., 2021*]. Pomegranate promotes apoptosis and possesses antioxidant, anti-inflammatory, anti-proliferative, anti-angiogenic, anti-invasive, and anti-metastatic properties. It appears that pomegranate can be utilized in control and therapy of cancer without harming the body [*Khwairakpam A et al., 2018*]. Our purpose in the present study was to investigate the anticancer effects of the ethanolic extract of pomegranate flowers.

Material and methods

Cells

The human breast cancer cell line (MCF-7) and normal mouse fibroblast cells (L929) were prepared at the Traditional Medicine Institute of Isfahan, Iran. Cells were cultured in RPMI-1640 medium (SIGMA, USA) supplemented with 10% Fetal Bovine Serum, gentamicin (0.001%), and amphotericin (0.001%) and incubated in a 5% CO 2 incubator at 37°C.

Plant collection and extraction

Punica granatum var. Pleniflora (P. granatum pleniflora) flowers have been collected from the Golestan provinces, Iran, and dried in a shaded environment at a low temperature (25 °C). The flowers were then mechanically crushed into a powder before extraction and put through a mesh filter with 80 and 100 *m* diameters. The maceration procedure was conducted for the extraction.

According to this method, 750 *g* of powdered flowers was added to 70% ethyl alcohol (ratio

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3:1.5 lit) and was mixed via a magnetic mixer for 96 hours. The Erlenmeyer flask was sealed with parafilm to prevent solvent evaporation and contamination. The supernatant portion was separated and filtered. The resulting solution was concentrated at 40°C in a Laborota 4001 rotary evaporator (Heidolph, Germany) with a vacuum. The dried ethanolic extract was kept at 4°C and in darkness in sterile containers [*Gavanji S et al., 2014a*].

Cytotoxicity assay determination using MTT assay

The cytotoxicity of P. granatum pleniflora flowers was examined using the assay 3-(4, 5 dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide (MTT) salt (Roche Diagnostics GmbH, Germany) and human breast cancer cell line (MCF-7) and normal mouse fibroblast cells (L929).

A 96-well flat bottom plate was filled with 180 µl of cell suspension at a concentration of 5×10 4 cells per *ml* and incubated for 24 hours at 37°C with 5% CO 2. Then, varied concentrations of P. granatum pleniflora ethanol extract (100-1000 µg/ml) were added to each well. Dimethyl sulfoxide (DMSO) (Merck, Germany) with a concentration of 2% (v/v) was used as a negative control. The plate was incubated at 37°C with 5% CO 2 for 24, and 48 hours. Next, 20 µL of MTT solution was added to each well at different incubation times (24 and 48 hours) and incubated in a humid atmosphere with 5% CO 2 for 4 hours. Then, 100 µl DMSO was added to each well to dissolve the formosan crystals. The absorbance was read at 560 *nm*. Percent viability was reported as half of the maximum inhibitory concentration (CC 50 value) [*Gavanji S et al., 2014b*].

Statistical analysis

One-way ANOVA was used to analyze the data using GraphPad Prism 6 (GraphPad Software, La Jolla, CA, USA). Tukey's multiple comparison tests were used to compare means. At p< 0.001, differences were considered significant.

Results

Table 1 shows the cytotoxic effect of various concentrations of ethanolic extract of *P. granatum* var. Pleniflora flowers on MCF-7 cells at 24 and 48 hours. The findings of the current investigation showed that *P. granatum* ethanolic extract at concentrations of 100 and 150 *µg/ml* in the first 24 hours and 100 *µg/ml* in the first 48 hours had no impact on MCF-7 cells. However, increasing the quantity of ethanolic extract of *P.granatum* boosted its capacity to kill cancer cells. *P. granatum* ethanolic extract at 450 *µg/ml* completely eliminated MCF-7 cells in 24 and 48 hours. Additionally, our investigation showed that the cytotoxic action of doses between 150 and 400 µg/ml is significantly affected by time (p<0.05, Fig. 1).

Table 1.

Cytotoxic activity of different concentrations of ethanolic extract of Punica granatum var. Pleniflora on MCF-7 cells

Concetration (*µg/ml*)	Cytotoxic activity	
	24 hours	48 hours
100	100.00±0.00[a]	100.00±0.00[a]
150	96.23±1.25[a]	90.13±1.90[b]
200	81.87±1.64[b]	74.77±0.59[c]
250	64.60±1.54[c]	54.83±3.69[d]
300	41.93±1.79[d]	35.17±2.35[e]
350	19.83±0.76[e]	14.53±2.15[f]
400	8.17±2.25[f]	1.33±2.31[g]
450	00.00±0.00[g]	00.00±0.00[g]

Note: Different letters indicate stastically significant differences (P<0.05

The cytotoxic effects of *P. granatum* ethanolic extracts on L929 cells are displayed in table 2. *P. granatum* extract at 650 and 700 *µg/ml* concentrations after 24 hours and 650 *µg/ml* concentration after 48 hours showed no impact on the survival of these cells. The cytotoxic rate of *P. granatum* on L929 cells was dose-dependent, nevertheless; as a result, the concentration of 1000 µg/ml in the first

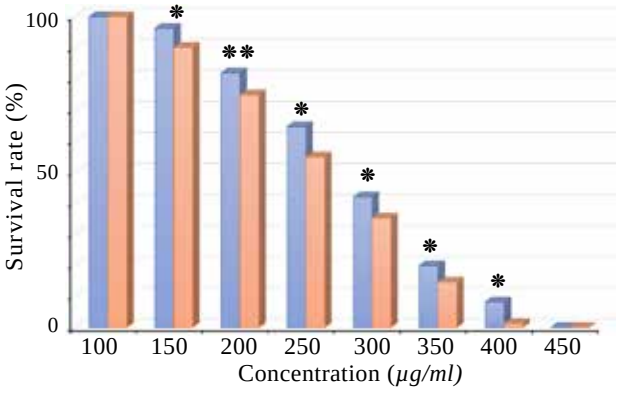

Figure 1. *The survival rate of MCF-7 cells against different concentrations of ethanolic extract of Punica granatum flower in 24 (left columns) and 48 hours (right columns). (* Statistical significance at p< 0.05, ** Statistical significance at p< 0.01)*

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TABLE 1.

Cytotoxic activity of different concentrations of ethanolic extract of Punica granatum var. Pleniflora on fibroblast cells (L929)

Concetration (*µg/ml*)	Cytotoxic activity	
	24 hours	48 hours
100	100.00±0.00[a]	100.00±0.00[a]
150	94.60±3.48[a]	90.17±3.92[b]
200	79.17±1.11[b]	74.40±3.38[c]
250	66.63±2.49[c]	63.90±3.47[d]
300	53.27±2.48[d]	48.40±2.15[e]
350	31.67±1.94[e]	26.90±1.91[f]
400	18.20±2.41[f]	9.40±4.28[g]
450	1.67±2.89[g]	00.00±0.00[h]

Note: Different letters indicate stastically significant differences (P<0.05

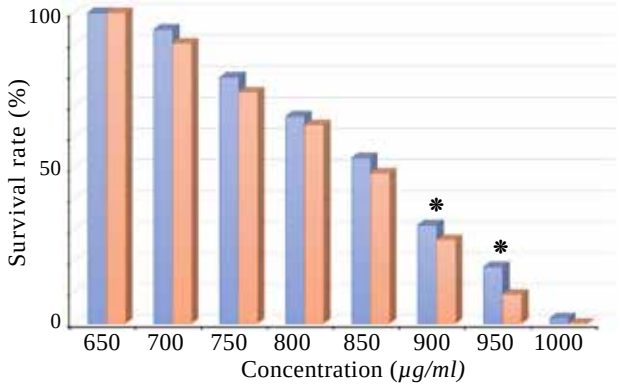

FIGURE 2. *The survival rate of L929 cells against different concentrations of ethanolic extract of Punica granatum flower in 24 (left columns) and 48 hours (right columns). (* Statistical significance at p<0.05)*

24 hours had the maximum level ($p < 0.05$), and after 48 hours it resulted in the death of all L929 cells ($p < 0.05$). The effect of time was significant for the toxicity of *P. granatum* ethanolic extract in L929 cells at concentrations of 900 and 950 *µg/ml* ($p < 0.05$, Fig. 2).

According to the current study, P. granatum extract has an IC 50 value in cancer cells of 279.92, which is lower than its IC 50 value in normal cells of 844.21 (Table 3).

DISCUSSION

Recent studies have found that many medicinal plants can be used for developing new drug formulations [*Eghbali S et al., 2021*]. Herbal medicines have been considered from several perspectives, including cost, effectiveness, and safety. Further, these compounds may act synergistically with chemotherapy to lessen adverse effects [*Ayaz M et al., 2022*]. It has been proven that the pomegranate contains potent therapeutic elements against breast tumors. Various types of phytochemical components, such as ellagitannins, gallotannins and derivatives, flavonoids, lignins, triterpenoids and phytosterols, fatty acids and lipids, organic acid, and phenolic acids, have been identified in pomegranate [*Wu S, Tian L, 2017; Singh B et al., 2018*]. Research showed that flavonoids obtained from pomegranate have antioxidant activity similar to green tea, which was significantly higher than red wine. Pomegranate skin contains substances that have been shown to have anti-tumor effects, including corilagin and pseudopelletierine [*Khwairakpam A et al., 2018*]. These compounds may prevent the proliferation of cancer by reducing oxidative stress and inflammation [*Eghbali S et al., 2021*]. Furthermore, it has been established that consuming pomegranate seed oil extract reduces the expression of pro-inflammatory cytokines in breast cancer, depending on the dose of the extract, including Tumor necrosis factor (TNF)-α, Interleukins (such as IL-1β, IL-2, IL-6, IL-8, IL-12, and IL17), Macrophage Inflammatory Protein (MIP-1α, MIP-1β) [*Khwairakpam A et al., 2018*], induced protein 10 (IP-10), and monocyte chemoattractant protein (MCP)-1.

Most of the studies related to the medicinal effects of this plant have focused on the juice or whole pomegranate fruit [*Melgarejo-Sánchez P et al., 2021*]. We investigated the effects of pomegranate flowers on breast cancer cells in this study. Our study showed that the toxicity of P. granatum ethanolic extracts is much lower for normal cells than for MCF-7 cells. As a result,

TABLE 3

Assessment of IC_{50}, and R^2 in MCF-7 and L929 cell lines

IC50 equation for	
MCF-7 *cells*	*L929* cells
y = -0.3212x + 139.91	y = -0.292x + 296.51
R^2 = 97.85%	R^2 = 98.84
CC_{50}=279.92	CC_{50}=844.21

NOTES: *(R^2) is a number between 0 and 1 that the closer R^2 value to 1, shows the better and the greater ability of this model, (X) is the ethanolic extract of Punica granatum flowers concentration*

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150 and 450 µg/ml concentrations of the P. granatum flower had the minimum and maximum toxicity in normal cells, whereas 700 and 1000 µg/ml were found to be the minimum and maximum toxicity in MCF-7 cells.

It is reported that The LLC-MK2 cells were unaffected by ethanolic extracts of pomegranate bark (PBE) and pomegranate peel (PPE) at 1000 *µg/ml*. Additionally, PBE and PPE in therapeutic concentrations of 250 and 1000 *µg/ml* had no adverse effects on BHK-21 fibroblast cells. Both extracts significantly inhibited the proliferation of Hep-G2 cells (human liver cancer cell line) and HeLa cells at 10 and 50 *µg/ml* concentrations, respectively. It has been stated that the mechanism of antiproliferative effects in PBE and PPE on human hepatocellular carcinoma is probably related to the reduction in ERK1/2 (extracellular signal-related kinases 1 and 2) expression [*Leesombun A et al., 2022*]. Keta O. and co-authors (2020) showed that pomegranate peel extract (PP) has significant cytotoxicity for cancer cells, including HTB140, HTB177, MCF7, and HCT116, in contrast to normal cells [*Keta O et al., 2020*]. Another study showed that pomegranate juice extract had no cytotoxic effect on breast fibrocystic epithelial cell lines (MCF-10A cells) but decreased MCF-7 cell viability. It was claimed that the cytotoxicity effects on breast cancer cells increased with the concentration of anthocyanins such as cyanidin-3-O-glucoside, cyanidin chloride and punicalagin [*Eroglu Ozkan E et al., 2021*]. It seems that the polyphenols in pomegranate, such as punicalin, punicalagin, and ellagic acid, perform their anticancer activity by keeping the cell cycle in the G2/M phase, as well as inducing apoptosis and DNA damage in cancer cells [*Sharma K et al., 2022*].

Conclusion

The current study stated that P. granatum flowers have anti-cancer properties against breast cancer cells, so it can be useful in herbal remedies for cancer treatment. At the same doses, P. granatum flowers ethanoic extract had no effect on L929 cells compared with cancer cells.

Nonetheless, additional *in vivo* and *in vitro* studies should be performed to prove the therapeutic and none side effects of P. granatum flowers.

REFERENCES

1. *Ayaz M, Nawaz A, Ahmad S, Mosa OF, Eisa Hamdoon AA., et al (2022).* Underlying anticancer mechanisms and synergistic combinations of phytochemicals with cancer chemotherapeutics: potential benefits and risks. J Food Qual. 1-15
2. *Baci GM, Baciu ED, Cucu AA, Muscă AS, Giurgiu AL., et al (2023).* Sericultural By-Products: The Potential for Alternative Therapy in Cancer Drug Design. Molecules. 28(2): 850
3. *Barrios CH (2022).* Global challenges in breast cancer detection and treatment. The Breast. 62: S3-S6
4. *Burguin A, Diorio C, Durocher F (2021).* Breast cancer treatments: updates and new challenges. J Pers Med. 11(8): 808
5. *de Ligt K, de Rooij B, Hedayati E, Karsten M, Smaardijk V., et al (2023).* International development of a patient-centered core outcome set for assessing health-related quality of life in metastatic breast cancer patients. Breast Cancer Res Treat. 1-17
6. Debien V, De Caluwé A, Wang X, Piccart-Gebhart M, Tuohy VK., et al (2023). Immunotherapy in breast cancer: An overview of current strategies and perspectives. NPJ Breast Cancer. 9(1): 7
7. *Dehghan M, Hoseini FS, Mohammadi Akbarabadi F, Fooladi Z, Zakeri MA (2022).* Quality of life in terminally ill cancer patients: what is the role of using complementary and alternative medicines? Support Care Cancer. 30(11): 9421-9432
8. *Eghbali S, Askari SF, Avan R, Sahebkar A (2021).* Therapeutic effects of Punica granatum (pomegranate): an updated review of clinical trials. J Nutr Metab. doi: 10.1155/2021/5297162
9. *Eroglu Ozkan E, Seyhan MF, Kurt Sirin O, Yilmaz-Ozden T, Ersoy E., et al (2021).* Antiproliferative effects of Turkish pomegranate (Punica granatum L.) extracts on MCF-7 human breast cancer cell lines with focus on antioxidant potential and bioactive compounds analyzed by LC-MS/MS. J. Food Biochem. 45(9): e13904

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10. *Gavanji S, Larki B, Bakhtari A (2014a).* The effect of extract of Punica granatum var. pleniflora for treatment of minor recurrent aphthous stomatitis. Integr Med Res. 3(2): 83-90

11. *Gavanji S, Mohammadi E, Larki B, Bakhtari A (2014b).* Antimicrobial and cytotoxic evaluation of some herbal essential oils in comparison with common antibiotics in bioassay condition. Integr Med Res. 3(3): 142-152

12. *Grimm D, Schulz H, Krüger M, Cortés-Sánchez JL, Egli M, Kraus A., et al (2022).* The fight against cancer by microgravity: the multicellular spheroid as a metastasis model. Int J Mol Sci. 23(6): 3073

13. *Han G, Lee YS, Jang HJ, Kim SY, Lee YJ, Ha IH (2022).* Symptom management and quality of life of breast cancer patients using acupuncture-related therapies and herbal medicine: A scoping review. Cancers. 14(19): 4683

14. *Hashem S, Ali TA, Akhtar S, Nisar S, Sageena G, Ali S, et al (2022).* Targeting cancer signaling pathways by natural products: Exploring promising anti-cancer agents. Biomed Pharmacother. 150: 113054

15. *Houghton SC, Hankinson SE (2021).* Cancer progress and priorities: breast cancer. Cancer Epidemiol Biomarkers Prev. 30(5): 822-844

16. *Keta OD, Deljanin M, Petković V, Zdunić G, Janković T., et al (2020).* Pomegranate (Punica granatum L.) Peel Extract: potential cytotoxic agent against different cancer cell lines. Rec Nat Prod. 14(5): 326-339

17. *Khwairakpam AD, Bordoloi D, Thakur KK, Monisha J, Arfuso F., et al (2018).* Possible use of Punica granatum (Pomegranate) in cancer therapy. Pharmacol. Res. 133: 53-64

18. *Koss-Mikołajczyk I, Todorovic V, Sobajic S, Mahajna J, Gerić M., et al (2021).* Natural products counteracting cardiotoxicity during cancer chemotherapy: the special case of doxorubicin, a comprehensive review. Int J Mol Sci. 22(18): 10037

19. *Leesombun A, Sariya L, Taowan J, Nakthong C, Thongjuy O, Boonmasawai S (2022).* Natural antioxidant, antibacterial, and antiproliferative activities of ethanolic extracts from Punica granatum L. tree barks mediated by extracellular signal-regulated kinase. Plants. 11(17): 2258

20. *Lovelace DL, McDaniel LR, Golden D (2019).* Long-term effects of breast cancer surgery, treatment, and survivor care. J. Midwifery Womens Health. 64(6): 713-724

21. *Marra F, Petrovicova B, Canino F, Maffia A, Mallamaci C, Muscolo A (2022).* Pomegranate wastes are rich in bioactive compounds with potential benefit on human health. Molecules. 27(17): 5555

22. *Melgarejo-Sánchez P, Nunez-Gomez D, Martínez-Nicolás JJ, Hernández F, Legua P, Melgarejo P (2021).* Pomegranate variety and pomegranate plant part, relevance from bioactive point of view: A review. Bioresour. Bioprocess. 8: 1-29

23. *Moo TA, Sanford R, Dang C, Morrow M (2018).* Overview of breast cancer therapy. PET Clin. 13(3): 339-354

24. *Satapathy S, Patro CS, Patro G, Panda M, Patra A (2023).* Cancer therapy. J Pharm Negat Results. 3643-3649

25. *Sharma A, Sharma L, Nandy SK, Payal N, Yadav S, Vargas-De-La-Cruz C., et al (2023).* Molecular aspects and therapeutic implications of herbal compounds targeting different types of cancer. Molecules. 28(2): 750

26. *Sharma K, Kesharwani P, Prajapati SK, Jain A, Jain D., et al (2022).* An insight into anticancer bioactives from Punica granatum (Pomegranate). Anticancer Agents Med Chem. 22(4):694-702

27. *Singh B, Singh JP, Kaur A, Singh N (2018).* Phenolic compounds as beneficial phytochemicals in pomegranate (Punica granatum L.) peel: A review. Food Chem. 261: 75-86

28. *Toohey K, Hunter M, McKinnon K, Casey T, Turner M., et al (2023).* A systematic review of multimodal prehabilitation in breast cancer. Breast Cancer Res. Treat. 197(1): 1-37

29. *Wang KL, Yu YC, Chen HY, Chiang YF, Ali M., et al (2022).* Recent Advances in Glycyrrhiza glabra (Licorice)-Containing Herbs Alleviating Radiotherapy-and Chemotherapy-Induced Adverse Reactions in Cancer Treatment. Metabolites. 12(6): 535

30. *Wu S, Tian L (2017).* Diverse phytochemicals and bioactivities in the ancient fruit and modern functional food pomegranate (Punica granatum). Molecules. 22(10): 1606

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