RESEARCH PAPER

Elucidating The Contrasting Role Of Blackberry Anthocyanins In Cancer- A Scientific Scoping Review

Abhilipsa Arpita Acharya[1], Lubna Fathima[2]*, Gibbson Derick D[3], Rajmohan M[4], Dinesh Dhamodhar[5], Sindhu R[6], Prabu D[7]

[1] Undergraduate, SRM Dental college, Ramapuram, Bharathi salai, Chennai.
[2,6] MDS, Senior lecturer, Department of Public health dentistry, SRM Dental college, Ramapuram, Bharathi salai, Chennai.*
[3] Postgraduate, Department of Public health dentistry, SRM Dental college, Ramapuram, Bharathi salai, Chennai.
[4,5] MDS, Reader, Department of Public health dentistry, SRM Dental college, Ramapuram, Bharathi salai, Chennai.
[6] PhD, Head of the Department, Department of Public health dentistry, SRM Dental college, Ramapuram, Bharathi salai, Chennai

ABSTRACT

Background: The antioxidant and anti-inflammatory qualities of blackberry anthocyanins have led to a great deal of research on their possible anticancer effects. The intricacy of anthocyanins' role in cancer is highlighted by recent research that indicates they may have pro-cancerous effects in particular situations.

Aim and Objective: This systematic review's objectives are to summarise existing research, pinpoint knowledge gaps, and guide future investigations in order to clarify the conflicting roles of blackberry anthocyanins in cancer. The aim of this systematic review is to thoroughly examine the body of research on blackberry anthocyanins and their connection to cancer, with an emphasis on figuring out the mechanisms behind their disparate effects.

Materials and Methods: Several databases, such as PubMed, Scopus, and Web of Science, were used to perform an extensive literature search. Included were studies that looked at how blackberry anthocyanins affected animal models or cancer cells. Blackberry anthocyanins, cancer, anticancer effects, and pro-cancerous effects were among the search terms.

Results: With both pro- and anti-cancerous effects documented, the review emphasises the complex role of anthocyanins in cancer. The findings imply that a number of variables, such as the anthocyanins' concentration and structure, the kind of cancer cells, and the cellular environment, may influence how blackberry anthocyanins affect cancer cells.

Conclusion: A thorough summary of the conflicting roles that blackberry anthocyanins play in cancer is given by this scientific scoping review. According to the findings, more investigation is required to elucidate the mechanisms behind these conflicting effects and investigate the potential therapeutic uses of blackberry anthocyanins in the prevention and treatment of cancer...

How to cite this article: Acharya AA, Fathima L, D D G, Rajmohan M, Dhamodhar D, Sindhu R, Prabu D. Elucidating The Contrasting Role Of Blackberry Anthocyanins In Cancer- A Scientific Scoping Review .Int J Drug Deliv Technol. 2026;16(1s): 276-288; DOI: 10.25258/ijddt.16.1s.35

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

As the world's second greatest cause of mortality, cancer has a substantial impact on public health. The growing resistance of cancer to existing treatment methods highlights the potential function of phytotherapy. Blackberries and other berries are rich in anthocyanins, a class of potent pigments and antioxidants. These substances have attracted a lot of interest lately because of their possible health advantages, especially when it comes to the prevention and treatment of cancer [1]. It is interesting to note that blackberry anthocyanins seem to have a complex and even contradictory impact in cancer. Anthocyanins have been demonstrated to have pro-apoptotic, anti-inflammatory, and anti-proliferative qualities, which may be part of their anti-cancer benefits. Anthocyanins' antioxidant and free-radical scavenging properties may also aid in preventing the development and spread of cancer. However, additional research indicates that anthocyanins might also have pro-cancer effects in specific circumstances, such as encouraging angiogenesis, metastasis, and cancer cell survival[2]. The precise kind and concentration of anthocyanins, the kind of cancer cell, and the stage of cancer advancement are some of the variables that may influence the underlying mechanisms for these conflicting effects, which are still not entirely understood.Dark-coloured foods, such as blackberries, contain potent

**Author for Correspondence: Abhilipsa Arpita Acharya*

antioxidants called anthocyanins. According to research, these substances might have either pro- or anti-cancer effects, depending on the situation. Because berries are more abundant than other fruits yet contain fewer other macromolecules, such as indigestible proteins and carbs, it is hypothesized that their (poly)phenol bio accessibility is higher [3] .The genus Rubus L. is a very diverse group of plants Blackberry and raspberry species, such as Rubus fruticosus and Rubus idaeus have a high content of polyphenols, and the most common (poly)phenols are anthocyanins, ellagitannins, and ellagic acid conjugates. The distinctive pigmentation of raspberries and blackberries is caused by anthocyanins; cyanidin 3-O-glucoside (C3G) is more common in blackberries and cyanidin 3-sophoroside in raspberries. Blackberries are currently one of the most popular berry plants in the world [4] . In a similar vein, raspberries have become much more popular worldwide, both for human consumption and as an ingredient in industrial food applications. Numerous recent studies that solely focus on the effects of those two berries in diverse circumstances demonstrate the ongoing scientific interest in these species, which is another indication of their high appeal. Nonetheless, it is important to consider the strength of other Rubus species, such as the increasingly well-liked Nordic Rubus chamaemorus (cloudberry) While raspberries have also been linked to comparable positive effects, blackberry consumption has been linked to neuroprotective, hypoglycemic, hypolipidemic, antioxidant, anti-inflammatory, anticancer, and cardioprotective effects [5].Due to poor intestinal absorption, individual anthocyanins are typically found in plasma at concentrations of less than 1% of the total amounts taken, despite their demonstrated health benefits. Their bioavailability, however, may be impacted by additional factors, such as elevated rates of cellular absorption, metabolism, and excretion. Their metabolites are thought to be the cause of the positive effects due to their limited absorption and gut accumulation . However, there are a number of pathways involved in the related mechanisms that are linked to the bioactivity of phenolic compounds and anthocyanins. A fruit high in ellagic acid, ellagitannins, and anthocyanins is the black raspberry (BRB, Rubus Occidentalis). Growing data points to BRB's potential anticancer properties, making it a strong contender for phytotherapy [6].By focusing on several pathways, BRB has been shown to affect several cancer hallmarks. By regulating oestrogen metabolism and breaking down free radicals, BRB can lessen the harm that reactive oxygen species due to DNA. Additionally, BRB can improve the ability of nucleotide excision repair to fix DNA damage. BRB can promote apoptosis and pyroptosis, induce cell cycle arrest, and increase the expression of tumour suppressor genes through epigenetic regulation. By suppressing glycolysis and lowering angiogenesis, BRB can lower the energy and nutrition supply to the cancer nest. BRB can help improve the inflammatory and immunological milieu around cancer cells, preventing the development and spread of cancer. Anthocyanins are among the several polyphenols found in blackberries[7]. It is believed that polyphenols have biological properties that could improve human health. In these investigations, an anthocyanin-rich extract was extracted from Kentucky-grown Hull blackberries and thoroughly evaluated in terms of polymeric colour, anthocyanin composition, total antioxidant capacity, and total anthocyanin and phenolic content. Blackberry extract suppressed HT-29 colon tumour cell development in a concentration-dependent manner, according to in vitro cell culture experiments. At 72 hours, 49.2 microg of total anthocyanins/mL inhibited HT-29 cell growth by 66%. Similarly, total anthocyanin concentrations between 0 and 40 microg/mL inhibited the release of interleukin-12 from mouse bone marrow-derived dendritic cells at both low and high doses of lipid A (10 and 0.1 microg/mL), respectively, in a concentration-dependent manner. According to these findings, Hull blackberry extract (HBE) possesses strong anti-inflammatory, antiproliferative, and antioxidant properties. Products made with HBE may be used to treat or prevent cancer and other inflammatory illnesses [8] . By outlining the possible advantages and disadvantages of consuming blackberry anthocyanins, this review seeks to provide an overview of the present body of research regarding their conflicting roles in cancer. We want to offer a thorough grasp of the intricate connections between anthocyanins, cancer, and human health by analysing the available data and pinpointing areas in need of additional study[9].

MATERIALS AND METHODS

This scientific scoping review was conducted to know about Blackberry Anthocyanins that have shown to possess anti-cancer properties including anti-proliferative, pro-apoptotic, and anti-angiogenic effects. However, the role of blackberry anthocyanins in cancer is complex and appears to be context-dependent. Some studies suggest that these compounds may apply anti-cancer effects by modifying/adjusting various signalling pathways, while others suggest that they may have pro-cancer effects under certain conditions.

The contrasting role of blackberry anthocyanins in cancer emphasizes the need for a thorough analysis of the body of research that is necessary to clarify the mechanisms behind the anti-cancer and possibly pro-cancer actions of blackberry anthocyanins.

INFORMATION SOURCES

Articles were referred and collected from databases such as PubMed and Google Scholar.

SEARCH STRATEGY

Search labels used for identification of the studies were : “Blackberry Anthocyanins AND Cancer”, “Blackberry Anthocyanins OR Cancer”, “ Syzigium cumini AND Cancer”, “Syzigium cumini OR Cancer”, “Elucidating the contrasting role of blackberry anthocyanins in cancer”.

INCLUSION CRITERIA

The inclusion criteria for this study were Randomized Control Trials from 2008-2022, Cohort Study-2025, Crossover Design Trial from 2006-2011.

It included two full texts and others were abstracts published in English.

EXCLUSION CRITERIA

Research that was identified including :

-Studies not focusing on blackberry anthocyanins and cancer

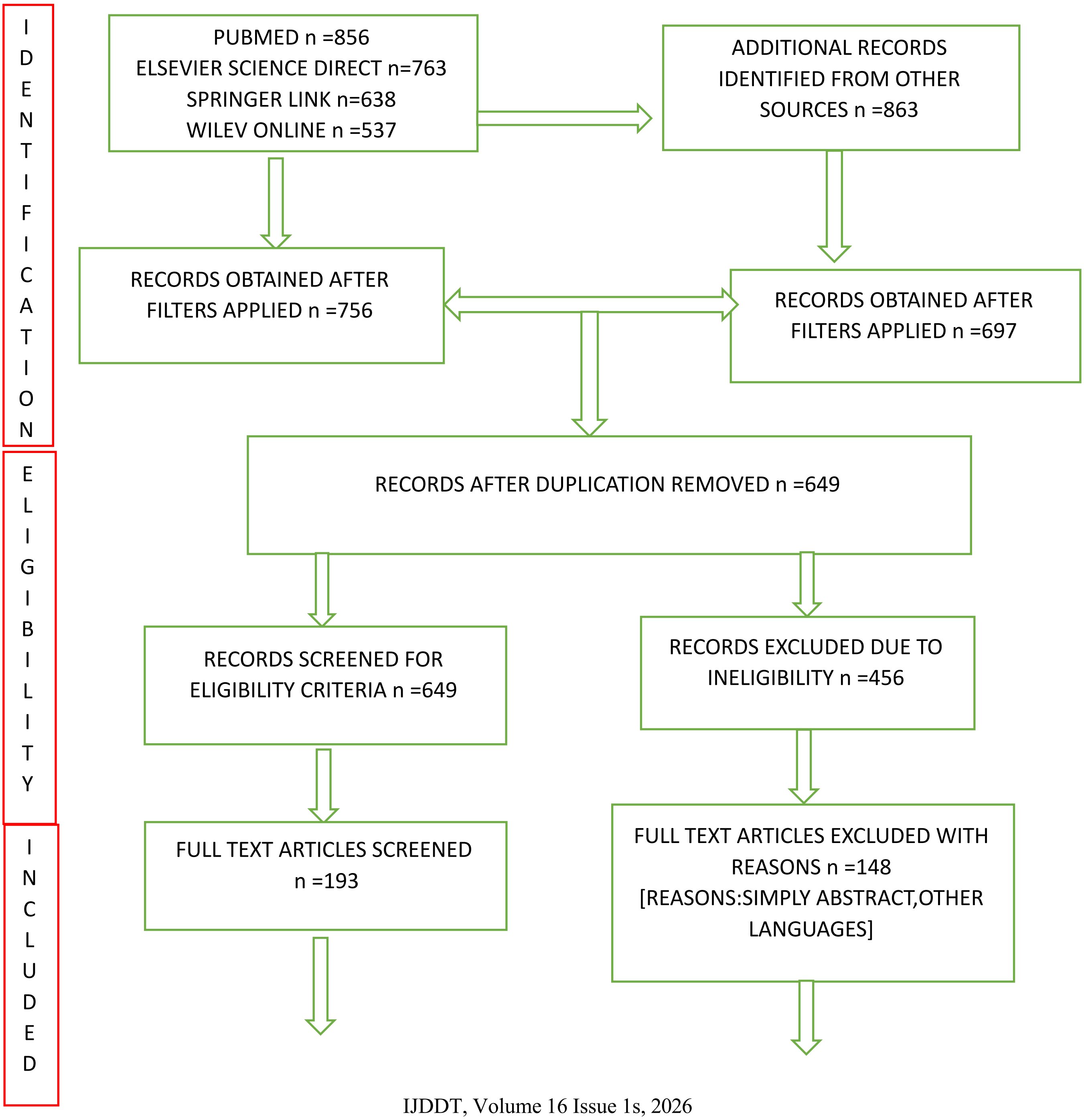
- Studies using non-blackberry anthocyanins

- Studies not published in English

- Studies involving experiments on animals

were excluded.

PRISMA DIAGRAM



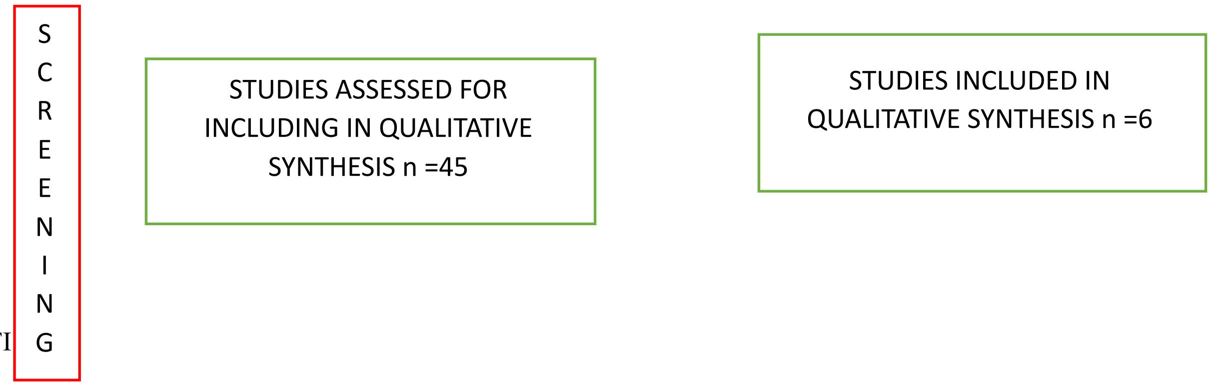


FIGURE 1 shows flow diagram illustrating the number of papers found, screened, evaluated for eligibility, omitted, and included in the systematic review.

TABLE 1: CHARACTERTIC FEATURES OF THE INCLUDED STUDIES

AUTHOR	**STUDY DESIGN**	**SAMPLE**	**INTERVENTION**	**RESULTS**
1.Nayara Simas Frauches et al, 2021 [11]	Randomized controlled trials	dried peel powder extracts of jabuticaba (*Myrciaria jaboticaba*, MJ), jamun-berry (*Syzygium cumini*, SC), on human colon adenocarcinoma cells.	The MTT assay revealed a decrease in HT-29 cell viability following treatment with M. jaboticaba extracts. Compared to the control group, flow cytometry demonstrated that the anthocyanin-rich extract treatment increased the number of apoptotic cells and inhibited cell growth by causing G2/M arrest.	total anthocyanin and phenolic compounds content (802.90 ± 1.93 and 2152.92 ± 43.95 mg/100 g respectively)
2.Indre Cechovicienee t al, 2025 [12]	Cohort Study	Blackberry pomace from berries of the cultivars 'Polar', 'Orkan', and 'Brzezina'	Blackberry pomace was extracted using microwave-assisted extraction (MAE), ultrasound-assisted extraction (UAE), and a combination of these two extraction techniques (MAE+UAE) from berries of the cultivars "Polar," "Orkan," and "Brzezina." The amount of total flavonoids, total anthocyanins, and total phenolics was measured using the spectrophotometric method. Using the MTT test, the extracts' cytotoxicity was assessed.	1%, 1.5%, 2%, and 2.5% best inhibited the viability of Caco-2 cells. better than CCD-18Co normal colon fibroblasts.

3.Navindra P Seeram et al, 2006 [13]	Crossover Design Trial	blackberry, black raspberry, blueberry, cranberry, red raspberry, and strawberry The major classes of berry phenolics were anthocyanins, flavonols, flavanols, ellagitannins, gallotannins, proanthocyanidins, and phenolic acids.	The phenolic components of extracts from six commonly consumed berries—strawberry, cranberry, blueberry, red raspberry, blackberry, and black raspberry—were assessed. The berry extracts' capacity to induce apoptosis in the COX-2-expressing colon cancer cell line, HT-29, was also assessed.	The berry extracts were evaluated for their ability to inhibit the growth of human oral (KB, CAL-27), breast (MCF-7), colon (HT-29, HCT116), and prostate (LNCaP) tumour cell lines at concentrations ranging from 25 to 200 micro g/mL.
4.Artemio Z Tulio Jr. et al, 2008 [14]	Randomized Controlled Trial	Anthocyanin constituents in black raspberries (Rubus occidentalis L.)	Black raspberries included five different types of anthocyanins: cyanidin 3-sambubioside, cyanidin 3-glucoside, cyanidin 3-xylosylrutinoside, cyanidin 3-rutinoside, and pelargonidin 3-rutinoside. Using Nuclear Magnetic Resonance[NMR] spectroscopy, their identities and structures were verified, with cyanidin 3-xylosylrutinoside receiving special attention.	cyanidin 3-rutinoside and cyanidin 3-xylosylrutinoside, predominated, comprising 24-40 and 49-58%, respectively
5.Jodee L Johnson et al, 2011 [15]	Crossover Design Trial	75 black raspberry extracts	5 black raspberry extracts were tested for their antiproliferative properties utilizing an in vitro colon cancer cell culture. Freeze-dried extracts were added to HT-29 cells cultured in 96-well plates at concentrations of 0.6 and 1.2 mg of extract per millilitre of media.	HT-29 cells grown in 96-well plates were treated with freeze-dried extracts at 0.6 and 1.2 mg of extract/mL of medium.

6.Delaram Moghadam et al 2022 [16]	Randomized Controlled Trial	blackberry juice and three berry-polyphenolic compounds	The effects of three berry-polyphenolic substances and blackberry juice on telomerase activity and cell proliferation in normal peripheral blood mononuclear cells (PBMCs) and human hepatoma HepG2. Telomerase activity and cell viability were assessed. The impact of berries on gene expression was identified.	Telomerase activity was induced by all 3 polyphenols in PBMCs

TABLE 2: OUTCOME CHARACTERSTICS FOR INCLUDED STUDIES

AUTHOR	OUTCOME
1.Nayara Simas Frauches et al, 2021 [11]	The results of this study demonstrate the potential of Myrtaceae fruit peel powders as a significant natural antioxidant source and a preventative measure against colon cancer.
2.Indre Cechoviciene et al, 2025 [12]	At concentrations of 1%, 1.5%, 2%, and 2.5%, the 'Orkan' cultivar's microwave-assisted extraction (MAE) and ultrasound-assisted extraction (UAE) extracts most effectively suppressed Caco-2 cell viability. The extracts were more effective than CCD-18Co normal colon fibroblasts at inhibiting the proliferation of the Caco-2 cell line.
3.Navindra P Seeram et al, 2006 [13]	The extracts from black raspberries and strawberries exhibited the strongest pro-apoptotic effects on the HT-29 cell line.
4.Artemio Z Tulio Jr. et al, 2008 [14]	In products made from black raspberry fruit that are used in clinical trials to treat different types of cancer, cyanidin 3-rutinoside and cyanidin 3-xylosylrutinoside show promising biological activity that could be utilized in combination with other naturally occurring bioactive chemicals.
5.Jodee L Johnson et al, 2011 [15]	The proliferation of HT-29 colon cancer cells was markedly and dose-dependently reduced by all extracts. Growth inhibition and extract total phenolic and total monomeric

	anthocyanin assays did not correlate, indicating that horticultural factors have a complicated impact on bioactivity.
6.Delaram Moghadam et al, 2022 [16]	HepG2 and PBMC cell proliferation was dose-dependently reduced by blackberry, gallic acid, and resveratrol. HepG2 cells' telomerase activity was markedly suppressed by berries, resveratrol, and gallic acid. Apoptotic DNA fragmentation was linked to the berry's antiproliferative action. However, in cancer cells, anthocyanin slightly raised telomerase activity. In cells treated with berries, there was a notable overexpression of SIRT1 and a considerable downregulation of HDAC1 and HDAC2.

Author	Random Sequence Generation	Allocation Concealment	Blinding of Participants & Personnel	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Reporting	No Other Bias	Overall Risk
Nayara Simas Frauches et al (2021)	Low Risk	Some concerns	Some concerns	Low Risk	Low Risk	Low Risk	Low Risk	Some concerns
Indrė Čechovičienė et al (2025)	High risk	High risk	High risk	High risk	Low Risk	Low Risk	Some concerns	High risk
Navindra P. Seeram et al (2006)	Some concerns	Some concerns	Some concerns	Low Risk	Low Risk	Low Risk	Low Risk	Some concerns
Artemio Z. Tulio Jr. et al (2008)	Low Risk	Some concerns	Some concerns	Low Risk	Low Risk	Low Risk	Low Risk	Some concerns
Jodee L. Johnson et al (2011)	Some concerns	Some concerns	Some concerns	Low Risk	Low Risk	Low Risk	Low Risk	Some concerns
Delaram Moghadam et al (2022)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low risk

TABLE:3 RISK OF BIAS ASSESSMENT AS INCLUDED IN THE STUDIES

Green | Low Risk | No or minimal risk of bias; study methods are appropriate and well reported

Yellow | Some Concerns | Some aspects are unclear or not fully reported, possibly affecting validity

Red | High Risk | Major methodological flaws or high potential for bias

DISCUSSION

Anthocyanins are dietary polyphenols, not essential nutrients like vitamins or minerals, so the body does not maintain a required. Anthocyanins are absorbed in the stomach and small intestine through glucose transporters such as SGLT1 and GLUT2, with a small portion entering circulation in intact glycoside form. Most unabsorbed anthocyanins reach the colon, where gut microbiota metabolize them into phenolic acids, which are then absorbed and further metabolized in the liver before systemic distribution. The average dietary intake is about 200 mg/day, while 100 g of fresh berries may provide 300–700 mg of anthocyanins. Supplement forms (capsules, tablets, or powders) example, Biotrex Nutraceuticals Bilberry Extract 275 mg ₹530 and HealthyHey Natural Bilberry Extract Capsules ₹635, typically contain 160–480 mg of standardized extract daily, equivalent to 50–120 mg of pure anthocyanins, often taken in divided doses with meals to improve absorption. These supplements are generally used by adults for antioxidant support, vascular health, metabolic regulation, and eye health, although their role in cancer prevention remains inconclusive due to limited human clinical evidence. While anthocyanins are considered relatively safe with only mild reported side effects such as gastrointestinal discomfort or headache, caution is advised for pregnant or breastfeeding women, children, individuals taking anticoagulant drugs, and patients with severe liver or kidney disorders. It is crucial to investigate the conflicting functions of blackberry anthocyanins in cancer because of their possible dual nature: although they have anti-inflammatory and antioxidant qualities that may prevent the development of cancer, some anthocyanins may also accelerate the spread of cancer in particular situations[10]. A scoping review can assist in combining current research, identifying knowledge gaps, and directing future studies to elucidate these conflicting effects and capitalize on the advantageous properties of blackberry anthocyanins for cancer prevention and treatment. A randomised controlled study comparing the antioxidant activity and antiproliferative effects of extracts from jabuticaba, jamun berry, and Malay apple on human colon adenocarcinoma cells (HT-29) was carried out by Nayara Simas Frauches et al. in 2021[11]. Limitations included comparison of only freeze-dried and dried peel extracts, limited cell lines (HT-29 only), and in vitro setting cancer effects in vivo. Future developments include mechanistic research, clinical trials for health benefits, testing on multiple cell lines, in vivo studies, and the creation of food products that use these fruits or extracts for health benefits. A cohort study involving blackberry pomace extracts from the cultivars "Polar," "Orkan," and "Brzezina" was carried out by Indre Cechoviciene et al. in 2025 [12]. Effects on Caco-2 and CCD-18Co cells were evaluated. There were restrictions on the number of cell lines and cultivars. Future developments will involve investigating additional cultivars, testing on various cancer cell lines, elucidating mechanisms, verifying effectiveness in animal models, and creating food items using extracts from blackberry pomace. The growth inhibition of human tumour cell lines by the phenolic components of six berries (strawberry, cranberry, red raspberry, blueberry, blackberry, and black raspberry) was the subject of a crossover design trial by Navindra P. Seeram et al.2006 [13]. Certain cell lines, a limited concentration range (25–200 μg/mL), and an in vitro environment were among the limitations. In vivo research, mechanistic research, health benefit clinical trials, berry phenolic bioavailability studies, and the creation of food products with berry extracts or powders to improve nutritional value are all future aspects. A randomised controlled study on the primary anthocyanin compounds in black raspberries and their antioxidant activity was carried out by Artemio Z. Tulio Jr. et al. 2008 [14]. In vitro assays, a narrow focus on anthocyanins, and a restriction to black raspberries were among the limitations. Future directions include developing food products with black raspberry bioactives , studying the biological and antioxidant effects of cyanidin compounds in vivo, researching the use of these anthocyanins to prevent cancer, and elucidating the mechanisms of action for the biological and antioxidant effects of these anthocyanin compounds. A crossover design study was carried out by Jodee L. Johnson et al. 2011[15] to evaluate the impact of horticultural factors on the antiproliferative activity of black raspberry extracts against HT-29 colon cancer cells. The in vitro environment, the use of only one cell line (HT-29), and the emphasis on total phenolics and anthocyanins were among the limitations. In vivo research on antiproliferative qualities, elucidating mechanisms of action, enhancing horticultural techniques to boost bioactivity, and pinpointing specific bioactive compounds in black raspberry extracts that contribute to antiproliferative effects are some future aspects.. A randomised control trial was carried out by Delaram Moghadam et al. 2022[16] to examine the effects of gallic acid, resveratrol, anthocyanin, and blackberry juice on telomerase activity and cell proliferation in HepG2 cells and PBMCs. Limited cell lines and an in vitro focus on particular compounds were among the limitations. In vivo research on anticancer properties, elucidating mechanisms of action, discovering more bioactive compounds in blackberries, and investigating therapeutic uses for cancer treatment utilising blackberries and their polyphenolic compounds are all future aspects. Through pathway targeting, DNA damage reduction, DNA repair enhancement, epigenetic regulation, inhibition of glycolysis and angiogenesis, and immune/inflammatory microenvironment amelioration, black raspberries (BRB) impact several cancer hallmarks. Anticancer efficacy is decreased by limited bioavailability. There are notable clinical advantages to topical BRB applications (gels, suppositories)[17]. By downregulating Sirtuin1 (SIRT1) expression and upregulating MOF and EP300 expression, BRB anthocyanins influenced the acetylation level. The results implied that the development of colorectal cancer regulated by BRB anthocyanins may be significantly influenced by protein acetylation[18]. The expression of HDAC1, HDAC2, and HDAC4 was found to decrease in cells treated for colorectal cancer in a dose-dependent and cell-type-specific manner[19]. These studies have provided mechanistic insights that suggest anthocyanins have multiple mechanisms of action. Anthocyanins exhibit anticancer effects mainly through antioxidant activity, inhibition of oxidative stress, and induction of apoptosis in cancer cells. In contrast, compounds from Aloe vera primarily reduce chemotherapy- and radiotherapy-induced inflammation while also showing antiproliferative effects. Gingerol, the active compound of ginger, mainly acts by modulating multiple signaling pathways that regulate cancer cell growth and survival.[20,21] These include influencing gene expression, regulating inflammatory mediators, modifying oxidative stress, and interacting with different cellular signalling cascades. Importantly, although in vitro research offers important insights into the molecular mechanisms underlying anthocyanin action, there are a number of obstacles to overcome before these findings can be applied to in vivo efficacy. Conducting long-term clinical trials is must to gain more therapeutic application[22].

CONCLUSION

The thorough analysis of numerous studies on berries, especially blackberries and black raspberries, reveals that their antioxidant and antiproliferative qualities may have anticancer effects. These effects are caused by bioactive substances such as resveratrol, gallic acid, and anthocyanins. To clarify their contradictory effects, more research is necessary due to the dual nature of anthocyanins in cancer . The limitations of the studies—limited cell lines, in vitro settings, and particular extraction techniques—highlight the need for more thorough investigation. To fully utilise the potential health benefits of berries and their compounds, future research is essential ·This includes mechanistic studies, clinical trials, in vivo studies, and the development of food products. Finally, new therapeutic approaches may be developed as a result of a better comprehension of the bioactive substances and their modes of action for cancer prevention and treatment..

REFERENCE

1. 1.Kaume L, Howard LR, Devareddy L. The blackberry fruit: a review on its composition and

chemistry, metabolism and bioavailability, and health benefits. J Agric Food Chem. 2012 Jun 13;60(23):5716-27. Doi: 10.1021/jf203318p. Epub 2011 Dec 8. PMID: 22082199.

2. Diaconeasa Z, Știrbu I, Xiao J, Leopold N, Ayvaz Z, Danciu C, Ayvaz H, Stănilă A, Nistor M, Socaciu C. Anthocyanins, Vibrant Color Pigments, and Their Role in Skin Cancer Prevention. Biomedicines. 2020 Sep 9;8(9):336. doi: 10.3390/biomedicines8090336. PMID: 32916849; PMCID: PMC7555344.

3.Skrovankova S, Sumczynski D, Mlcek J, Jurikova T, Sochor J. Bioactive Compounds and Antioxidant Activity in Different Types of Berries. Int J Mol Sci. 2015 Oct 16;16(10):24673-706. doi: 10.3390/ijms161024673. PMID: 26501271; PMCID: PMC4632771.

4. P N, Bhat R, Bhat SS. Pharmacogenomics in Pediatric Cancer Patients Treated with Irinotecan: A Systematic Review. Oral Sphere J. Dent. Health Sci. 2025;1(4):244-258. doi: 10.63150/osjdhs.2025.26

5.Martins MS, Gonçalves AC, Alves G, Silva LR. Blackberries and Mulberries: Berries with Significant Health-Promoting Properties. Int J Mol Sci. 2023 Jul 27;24(15):12024. doi: 10.3390/ijms241512024. PMID: 37569399; PMCID: PMC10418693.

6. Efferth T, Saeed MEM, Mirghani E, Alim A, Yassin Z, Saeed E, Khalid HE, Daak S. Integration of phytochemicals and phytotherapy into cancer precision medicine. Oncotarget. 2017 Jul 25;8(30):50284-50304. doi: 10.18632/oncotarget.17466. PMID: 28514737; PMCID: PMC5564849.

7. Waris G, Ahsan H. Reactive oxygen species: role in the development of cancer and various chronic conditions. J Carcinog. 2006 May 11;5:14. doi: 10.1186/1477-3163-5-14. PMID: 16689993; PMCID: PMC1479806.

8.Dai J, Patel JD, Mumper RJ. Characterization of blackberry extract and its antiproliferative and anti-inflammatory properties. J Med Food. 2007 Jun;10(2):258-65. doi: 10.1089/jmf.2006.238. PMID: 17651061.

9. Salehi B, Sharifi-Rad J, Cappellini F, Reiner Ž, Zorzan D, Imran M, Sener B, Kilic M, El-Shazly M, Fahmy NM, Al-Sayed E, Martorell M, Tonelli C, Petroni K, Docea AO, Calina D, Maroyi A. The Therapeutic Potential of Anthocyanins: Current Approaches Based on Their Molecular Mechanism of Action. Front Pharmacol. 2020 Aug 26;11:1300. doi: 10.3389/fphar.2020.01300. PMID: 32982731; PMCID: PMC7479177.

10.Stoner GD, Wang LS, Casto BC. Laboratory and clinical studies of cancer chemoprevention by antioxidants in berries. Carcinogenesis. 2008 Sep;29(9):1665-74. doi: 10.1093/carcin/bgn142. Epub 2008 Jun 9. PMID: 18544560; PMCID:

PMC3246882.

11. Simas Frauches N, Montenegro J, Amaral T, Abreu JP, Laiber G, Junior J, Borguini R, Santiago M, Pacheco S, Nakajima VM, Godoy R, Teodoro AJ. Antiproliferative Activity on Human Colon Adenocarcinoma Cells and In Vitro Antioxidant Effect of Anthocyanin-Rich Extracts from Peels of Species of the Myrtaceae Family. Molecules. 2021 Jan 22;26(3):564. doi: 10.3390/molecules26030564. PMID: 33498977; PMCID: PMC7865521.

12. Čechovičienė I, Tarasevičienė Ž, Hallman E, Jabłońska-Trypuć A, Česonienė L, Šileikienė D. Ultrasound and Microwave-Assisted Extraction of Blackberry (Rubus fruticosus L.) Pomace: Analysis of Chemical Properties and Anticancer Activity. Plants (Basel). 2025 Jan 27;14(3):384. doi: 10.3390/plants14030384. PMID: 39942946; PMCID: PMC11820506.

13. Seeram NP, Adams LS, Zhang Y, Lee R, Sand D, Scheuller HS, Heber D. Blackberry, black raspberry, blueberry, cranberry, red raspberry, and strawberry extracts inhibit growth and stimulate apoptosis of human cancer cells in vitro. J Agric Food Chem. 2006 Dec 13;54(25):9329-39. doi: 10.1021/jf061750g. PMID: 17147415.

14. Tulio AZ Jr, Reese RN, Wyzgoski FJ, Rinaldi PL, Fu R, Scheerens JC, Miller AR. Cyanidin 3-rutinoside and cyanidin 3-xylosylrutinoside as primary phenolic antioxidants in black raspberry. J Agric Food Chem. 2008 Mar 26;56(6):1880-8. doi: 10.1021/jf072313k. Epub 2008 Feb 22. PMID: 18290621.

15. Johnson JL, Bomser JA, Scheerens JC, Giusti MM. Effect of black raspberry (Rubus occidentalis L.) extract variation conditioned by cultivar, production site, and fruit maturity stage on colon cancer cell proliferation. J Agric Food Chem. 2011 Mar 9;59(5):1638-45. doi: 10.1021/jf1023388. Epub 2011 Feb 1. PMID: 21284384.

16. Moghadam D, Zarei R, Tatar M, Khoshdel Z, Mashayekhi FJ, Naghibalhossaini F. Anti-Proliferative and Anti-Telomerase Effects of Blackberry Juice and Berry- Derived Polyphenols on HepG2 Liver Cancer Cells and Normal Human Blood Mononuclear Cells. Anticancer Agents Med Chem. 2022;22(2):395-403. doi: 10.2174/1871520621666210315092503. PMID: 33719965.

17. Wang G, Su H, Guo Z, Li H, Jiang Z, Cao Y, Li C. Rubus Occidentalis and its bioactive compounds against cancer: From molecular mechanisms to translational advances. Phytomedicine. 2024 Apr;126:155029. doi: 10.1016/j.phymed.2023.155029. Epub 2023 Aug 16.PMID:38417241.

18. Chen L, Li M, Zhou H, Liu Y, Pang W, Ma T, Niu C, Yang Z, Chang AK, Li X, Bi X. Sirtuin1 (SIRT1) is

involved in the anticancer effect of black raspberry anthocyanins in colorectal cancer. Eur J Nutr. 2023 Feb;62(1):395-406. doi: 10.1007/s00394-022-02989-7. Epub 2022 Sep 3. PMID: 36056948.

19. Tatar M, Varedi M, Naghibalhossaini F. Epigenetic Effects of Blackberry Extract on Human Colorectal Cancer Cells. Nutr Cancer. 2022;74(4):1446-1456. doi: 10.1080/01635581.2021.1952454. Epub 2021 Jul 20. PMID: 34282673.

20. Sreenu B, Sindhu R, Banu Jothi A, Fathima L, Prabu D, Rajmohan M, et al. A systematic review of Aloe vera in chemotherapy- and radiotherapy-induced inflammation in cancer patients: unraveling antiproliferative and proapoptotic effects. Cuest Fisioter. 2025;54(4):50–56.

21. Noor JJ, Sindhu R, Jothi AB, Prabu D, Mohan MR, Dhamodhar D, et al. Modulatory effects of gingerol in cancer cell growth through activation and suppression of signaling pathways: a systematic review. J Pharm Bioallied Sci. 2024;16(Suppl 5):S4314–S4319. doi:10.4103/jpbs.jpbs_1001_24.

22. Kowalczyk T, Muskała M, Merecz-Sadowska A, Sikora J, Picot L, Sitarek P. Anti-Inflammatory and Anticancer Effects of Anthocyanins in In Vitro and In Vivo Studies. Antioxidants. 2024; 13(9):1143. https://doi.org/10.3390/antiox13091143