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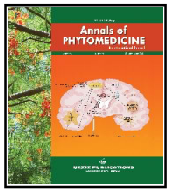

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Vegetables that heal: The magic of red colour vegetables on breast cancer

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Abstract

Globally, breast cancer is the leading cancer in the mammary gland of the female with high mortality rate, resulting serious health threat to public. The treatment of breast cancer options is crucial due to poor diagnosis and drug resistant to existing chemotherapeutic agents. The evidence-based analysis revealed the benefits of natural dietary foods such as vegetables for cancer prevention and treatment owing to its potential bioactive compounds which can reduce the cancer associated mortality. Exclusively, numerous bioactive compounds have distinct colour with different action in human body. Considering these facts, in this review, the anticancer properties of bioactive compounds such as lycopene, β-carotene, myricetin, betaine, quercetin, anthocyanin present in red coloured vegetables such as tomatoes, beetroot, red bell pepper and red onion against breast cancer cells and their mode of action have been investigated.

1. Introduction

Cancer is a collection of diseases which represents the unusual cell growth and spread in the human body and also produced severe physiological effects when it is left untreated. It remains a second leading cause of death globally, resulting serious threat to human health, creates severe economic burden in developed as well as developing countries owing to increased exposure of risk factors (Tan 2006; Pan American Health Organization, 2020). The cancer has occurred in any part of the tissue due to mutation in the normal cells creates the unsuitable environment which helps the cell neoplastic transformation (Gaikwad and Srivastava, 2021; Power and Robinson, 2006). Every year, more than millions of people were died owing to different types of cancer such as lung, breast, colon and prostate cancer. Among the others, breast cancer is the second leading cancer which represents 12% after the lung cancer in all populations, but it is the most important type of cancer which causes leading death globally in women's (Bray *et al.,* 2018). It becomes an important health issue in the population such as who are aged, non-communicable disease person and affected by other chronic diseases (Pisu *et al.,* 2017). Breast cancer is the most prevalent malignant tumor and also the rate of occurrence is increasing every year. The report says among eight women in the world, the one will get breast cancer due to various exogenous and endogenous risk factors including reproductive, genetic disorders, environmental factors and life style such as oral contraceptive use (Rieder *et al.,* 2016), early menarche (Bhadoria *et al.,* 2013), short term lactation (Ma *et al.,* 2017; Sisti *et al.,* 2016), alcohol consumption (Park *et al*., 2014), night work (Jia *et al*., 2013), diabetics (Charlot *et al*., 2017; Park *et al*., 2017) and obesity (Pierobon *et al.,* 2013). Among them, the genetic disorder corresponds to only 10% of all breast cancers (Campeau *et al*., 2008). The breast cancer is mainly an aggressive malignant tumor which is related to poor diagnosis and the survival rate is very minimal (Ferrini *et al*., 2015; Castello *et al*., 2015). The effective treatment option is the removal of breast followed by chemotherapy, hormone therapy and radiotherapy (Moulder and Hortobagyi, 2008). Unfortunately, the drug resistant and the undesirable side effects exhibited by current therapeutics limit the efficacy of the existing treatment option (Li *et al*., 2017; Cazzaniga and Bonanni, 2012). Therefore, the prevention of breast cancer is more critical. Current scenario triggered the researchers to discover the alternative treatment options for breast cancer prevention and treatment with lower side effects. Therefore, in this review mainly focused on the role of bioactive compounds from red colour vegetables in breast cancer prevention and treatment.

Dietary natural food has gained much attention on prevention and treatment approach for breast cancer. There is a cluster of natural dietary foods are showed their protective effect on breast cancer prevention and treatment (Zhang *et al*., 2016; Zheng *et al.,* 2016; Zhou *et al.,* 2016). The food and drug administration (FDA) and World health organisation's (WHO) have suggested that the regular intake of low fat content food, high fiber and consumption of vegetables and fruits along with some physical activity have decreases the overall cancer risks (Soerjomataram *et al.,* 2010; Turati *et al*., 2015; Justo *et al*., 2018). Besides, evidence from various epidemiological studies have highly recommended the consumption of vegetables, multigrains and fruits are reduced the breast cancer risk, recurrence and increase the survival rate (Farvid *et al.,* 2016; Grosso *et al.,* 2017). Particularly, some dietary foods are known for their dark colour pigments which accountable for anticancer bioactive compounds. Consequently, most of the plant based pigments from vegetables and fruits are notable by their prominent colours such as red, blue or purple, green, yellow and orange (Ahmad *et al*., 2019;

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Khoo *et al*., 2017; Chaudhary *et al*., 2018; Lee *et al*., 2017). Among them, red coloured fruits and vegetable are gaining much interest in the field of functional food science for the treatment of cancers owing to its specific bioactive compounds (Minich, 2019). Hence, in this review, we mainly focused on anti cancer activity of commonly used red coloured vegetables such as tomatoes, beetroot, red bell pepper, red onion, and their mechanism of action against breast cancer.

2. Anticancer activity of red coloured vegetables

2.1 Tomatoes

Tomatoes played a major role in balanced diet owing to its functional bioactive compounds such as lycopene, minerals, proteins, amino acids, potassium, polyphenols, flavonoids, carotenoids, *etc*. Considering the nutritional content, the tomato has been called as nutraceutical food due to their functional bioactive compounds which used to prevent the human diseases (Perveen *et al*., 2015; Beynon *et al*., 2019). The red colour of the ripen tomato due to the presence of carotenoid pigment called lycopene along with beta carotene which responsible for strong antioxidant potential and the ability for cancer prevention (Aghajanpour *et al.,* 2017). Keeping this in mind, a study reported intake of tomato and their products reduced risk of cancer among other vegetables. For example, many reports are available for the association between colour and their anticancer property through various mechaniam of action (Valderas-Martinez *et al*., 2016). When, the regular intake of tomatoes reduced plasma concentration and the cell adhesion property which is most important for cancer cell invasion and metastasis process (Etminan *et al.,* 2004; Serrati *et al*., 2020; Ohno *et al*., 2020). Here, some important bioactive compounds from carotenoids such as lycopene, polyphenols and flavonoids were discussed for their anticancer property.

Many studies emphasized the health benefits of regular intake of tomato and their derived metabolites greatly reduced the risk of cancers. Among the other carotenoides, lycopene is frequently present in tomato which contains unsaturated hydrocarbon along with conjugated and unconjugated double chains responsible for red colouration and the most studied bioactive compounds present in tomato against various cell lines (Puah *et al*., 2021; Madia *et al*., 2021). Consequently, the regular lysopene supplement reduced the IGF 1 level thereby decrease in the high risk of breast cancer (Voskuil *et al*., 2008; Grether-Beck *et al*., 2017). Many studies suggested the lycopene anticancer property against breast cancer and highlighted the molecular mechanisms responsible for the effect of lycopene. Besides, the molecular mechanism of lycopene against various breast cancer cell lines such as HER2 positive SK-BR-3, triple negative MDA-MB-468 and ER/PR positive MCF 7 were investigated and the dose and time dependent activity was observed against the above-mentioned cell lines by cell cycle arrest at G0/G1 phase. The lycopene exhibited greatest activity against MDA-MB-468 by apoptosis and also induced the ERK1/2 activation along with suppression of cyclin D1. Consequently, lycopene inhibit the Akt phosphorylation followed by proapoptotic Bax upregulation (Takeshima *et al*., 2014). In support of this, two studies were found the lycopene activity against breast cancer cell lines by suppression of anti apoptotic protein Bcl2 and up-of the proapoptotic protein BAX (Peng *et al*., 2017). Likewise, lycopene antiproliferative activity was investigated against MCF7 breast cancer cell line at different concentration and the activity was achieved by targeting gap junction intercellular communication and upregulation of connexin 43 expressions (Fornelli *et al*., 2007). Similarly, Gloria *et al*. (2014) analysed the antiproliferative activity of lycopene against breast cancer cell lines MDA-MB-231 and 235 and MCF7 through cell proliferation inhibition, increased cell apoptosis and cell cycle arrest at several phases. The same way, Nahum *et al*. (2001) analysed the molecular mechanism of lycopene against various breast cancer cell lines including MCF7 and MCF7.7D1.13 and found the IGF mitogenic activity inhibition and cyclin D1 reduction in MCF7 cells. Consequently, lycopene showed the antiproliferative, anti invasive and antimetastatic property against breast cancer lines MDA-MB-231 and MCF 10 by reduced the Akt and ERK1/2 phosphoration in MCF 10 revealed that these pathways played a major role in anticancer property of lycopene and also inhibited the cell migration, proliferation and invasion (Uppala *et al*., 2013; Koh *et al*., 2010). The lycopene can be used as a potential bioactive compound in the prevention and treatment of breast cancer due to its anticancer, anti-invasive, antimigrative and antiproliferative property with deciphered mode of action.

β-carotene, is a second most important carotenoid with potent anticancer property responsible for red-orange colours present in tomatoes. Consequently, the β-carotene was evaluated for anticancer property against breast cancer cells and the activity was observed *via* blocking the AKT and ERK1/2 activation through signalling pathways and reduced the anti oxidant enzyme SOD 2 level by down-regulating the Nrf 2 transactivation factor leading breast cancer cell dealth (Sowmya Shree *et al*., 2017). Interestingly, report from meta-analysis with 19450 breast cancer patients suggested that, regular intake of β-carotene is significantly enhanced the survival rate of 30% increase in breast cancer patients (He *et al*., 2018) and another study proved that higher concentration of β-carotene decreased the risk of breast cancer (Eliassen *et al*., 2015). Consequently, the enhanced cytotoxicity of carotene was observed when it was conjugated with liposome against breast cancer cells (Gina *et al*., 2022).

Myricetin from the group of flavonol is naturally found in tomatoes and their anticancer properties have been extensively studied (Barreto *et al*., 2016). The anticancer activity of myricetin was studied against breast cancer cells and the compound was able to inhibit the angiogenesis through down regulating the signalling pathways of p38MAPK and VEGF/VEGFR2 (Zhou *et al*., 2019). Similarly, in T47D breast cells, the myricetin induced cell death through apoptosis combined with increased apoptotic genes such as caspase 3, BAX/Bcl2 p53 expression (Soleimani *et al*., 2020).

2.2 Red beet root

The red beet root is one of the most colourful vegetables which contains plenty of rich nutrients such as fat, carbohydrates, micro-nutrients and functional bioactive compounds including betanin, betaine, betatine, carotenoids, saponins, polyphenols, pectin and betalains which is soluble in water (Lim, 2016). The red beet root is known for its anticancer and anti-inflammatory properties. Consequently, the anticancer activity of beetroot enriched with betanin extract was investigated against breast cancer cells and the activity was mediated by apoptosis. The high concentration of betanin causes cell death through proliferation inhibition, cell cycle progression inhibition and also cyclin down regulation in breast cancer cells (Nowacki *et al*., 2015). Similarly, betaine induced cell death in breast cancer cells *via* inhibition of alcohol induced transcription of

pol III, cell growth inhibition through down regulation of Brf1 and Pol III (Zhang *et al*., 2013). Other bioactive compound beta vulgarin was able to inhibit the breast cancer cell growth, colony formation and also reduced the CD44+/CD24 count as well as inhibited the Stat3/S Stat 3/Sox 2 signalling pathways in breast cancer cells (Liu *et al*., 2020). Another interesting study, the enhanced activity was observed when the red beet root extract was combined with doxorubicin against breast cancer cells *via* DNA intercalation mechanism (Kapadia *et al*., 2011). In addition, another bioactive compound from red beet root as pectin induced the cytotoxicity on MCF 7 breast cancer cells (Concha *et al*., 2013). The betaine had excellent anticancer activity in its higher concentration but the anticancer activity was increased when it was complexed with other potential compounds and showed synergism. Surprisingly, the enhanced activity of betaine was observed when it was complexed with *p*-SC4 and the activity was observed in various cells including breast cancer cells (Fahmy *et al*., 2021).

2.3 Red bell peppers

The bell pepper is most popular vegetable globally due to their varied colour ranges such as green, yellow and red as well as flavour and nutritional value (Bae *et al*., 2014). Among the other pepper, the red pepper gained more attention due to its high nutritional value and attractive colour. The red colour is due to the presence many carotenoids including β-carotene combined with pro vitamin, capsantine and phenolic compounds such as luteolin, quercetin and capsaicinoids which are known for their anti oxidant and anticancer properties (Rao *et al*., 2007). Among the others, β-carotene and quercetin played a major role in anticancer property of red bell pepper.

β-carotene is the most important carotenoid present in red bell pepper which possess various biological properties including anticancer activity and reduce the cancer risk (Saini *et al*., 2015; Pechinskii and Kuregyan, 2014). Consequently, the lycopene and β-carotene anti cancer property was evaluated against breast cancer cells. The cell viability was decreased after treatment with these carotenoids and the cell death was accomplished by increased cell apoptosis, inhibition of cell proliferation and cell cycle arrest at various cell stages. These findings suggested that carotenoids can be act as potential anti cancer agent against breast cancer cells (Gloria *et al*., 2014). In support of this, a study reported the β-carotene mechanism of action on breast cancer cell by arresting the cell cycle and apoptosis. β-carotene regulated the genes responsible for oxidative stress by inhibiting akt and ERK ½ signalling pathways and also suppress the expression of Bcl-2 and NF-kB and cysteine aspartic proteases activation which induced the apoptosis in breast cancer cells (Shree *et al*., 2017).

Quercetin is present in red pepper exhibited their anticancer properties against variety of cancers including breast cancer. Many epidemiological studies proved the anticancer activity of quercetin against breast cancer cells. Consequently, the quercetin can also overcome the side effect induced by cisplatin treatment. Surprisingly, the quercetin reduced the possible side effect induced by cisplatin such as kidney toxicity and also enhanced anti tumor activity was observed when it was combined with cisplatin against breast cancer induced *in vivo* mice model (Liu *et al*., 2019). Numerous studies reported the plant derived quercetin mode of action such as activating the apoptotic pathways, cell cycle arrest, MMP-2 and MMP-9 pathway inhibition against breast cancer cells (Kashyap *et al*., 2015). Same way, quercetin induced the cell death of breast cancer cell by apoptosis through up regulating the caspase 3 and 8 expression and also induction of PARP cleavage in over expressing HER2 breast cancer cells (Seo *et al*., 2016; Ranganathan *et al*., 2015). Similarly, it can also inhibit the G2M phase in cell cycle of breast cancer cells after treatment (Choi *et al*., 2001) and MMP-2 and MMP-9 (Lin *et al*., 2008). In addition, the quercetin induced cell death *via* targeting other pathways including Akt/AMPK/mTOR in breast cancer cells (Rivera *et al*., 2016; Jia *et al*., 2018).

2.4 Red onion

Globally, onion is the most commonly used vegetable in cooking and also a good source for bioactive compounds (Èrnivec *et al*., 2021). Several studies have reported the presence of flavanols, phenols, tannins, anthocyanins, ferulic acid, vanillic acid and flavanoids which has anticancer properties (Albishi *et al*., 2013; Ifesan, 2017; Yu *et al*., 2021). An epidemiological study reported the correlation of high intake of red onion (*Allium cepa*) which reduces the risk of cancer effects and their potential anti cancer property (Challier *et al*., 1998; Oancea *et al*., 2020; Li *et al*., 2017). Therefore, the ethanolic extract of red onion peel was investigated against breast cancer cell MDA-MB-231 resulting reduction in the cell proliferation and increased cell cycle arrest *via* phosphatidylinositol inhibition in breast cancer cell (Choe *et al*., 2020). The report says more bioactive compounds were present in onion peel compared to flesh onion (Campone *et al*., 2018) and it confer the therapeutic application in the treatment of various diseases such as cancer, cardiovascular diseases, obesity and microbial damage. Among the several bioactive compounds, quercetin and anthocyanin are played a major role in the therapeutic application in treating various diseases. Therefore, we focused the anti cancer properties of quercetin from red onion against breast cancer cells. The daily intake of quercetin reduces the tumor growth in breast cancer xenograft mice models (Wang *et al*., 2014; Zhao *et al*., 2016).

Consequently, numerous studies reported the *in vitro* and *in vivo* anti cancer activity of quercetin against breast cancer cells. But, the *in vitro* anticancer activity was mediated through prevention or inhibition of angiogenesis in breast cancer cells which resistant to tamoxifen while the *in vivo* activity was mediated by its antioxidant property (Oh *et al*., 2010; Baghel *et al*., 2012; Dajas *et al*., 2012). The enhanced activity of quercetin was observed when combined with doxorubicin against breast cancer cells which was T cell specific resulting improvement in the immune response against the tumor growth (Du *et al*., 2010). Here, it was noted that, due to its chemo-therapeutic activity, quercetin is preventing several cancer cell type proliferations through exhibiting various mode of actions such as attachment to cell receptors, inhibiting the enzymes and signalling pathways which are responsible for activation of carcinogens leading a strong anti cancer molecule against various tumour cells (Rauf *et al*., 2018; Gibellini *et al*., 2011). Also, quercetin showed the anticancer activity against MDA-MB-231 and MCF 7 by promoting cell apoptosis, miR-146a expression regulation, mitochondrial pathways inhibition and activating caspase pathways (Tao *et al*., 2015). Similarly, when the quercetin was used to treat the MCF 7 breast cancer cells, the activity was observed as dose and time dependent reduction in cell proliferation by Bax up-regulation and Bcl 2 down regulation (Duo *et al*., 2012). Same way, quercetin also inhibits the insulin receptor signalling pathways and inhibiting the target genes which involved in EMT reversal in MDA-MB-231 breast cancer cells (Srinivasan *et al*., 2016).

Anthocyanin is a water-soluble phenolic plant compound present in red onion and used as a dietary compound for various human diseases. Anthocyanin has exhibited their anticancer property against various cancer cell types by different mode of action. Consequently, the breast cancer cells exposed to anthocyanin, the activity was achieved by suppression of both mRNA and protein expression resulting inhibition in the cell cycle and VEGF signal pathways as well as miR-124 expression induction leads to angiogenesis in breast cancer cells (Ma *et al.,* 2019). Similarly, the anthocyanin anticancer activity was evaluated *in vitro* and *in vivo* against HER 2 positive and trastuzumab resistant breast cancer cells and also able to inhibit the cell growth, migration and invasion, phosphorylation and induce apoptosis (Li *et al*., 2016). The anti cancer activity of bioactive compounds from red colour vegetable against breast cancer cells and their mechanism of action are presented in Table 1.

Table 1: Bioactive compounds anticancer activity against breast cancer cells

Bioactive compounds	Red vegetables	Mechanism of action
Lycopene	Tomato	Cell cycle arrest, apoptosis, induced the ERK1/2 activation, suppression of cyclin D1, inhibition of Akt phosphorylation, Bax upregulation, IGF mitogenic activity inhibition
β-carotene	Tomato, red bell pepper	AKT and ERK1/2 activation block, reduction in antioxidant enzyme SOD 2 level, down-regulation of Nrf 2 transactivation
Myricetin	Tomato	Angiogenesis Inhibition, apoptosis, down regulation of signalling pathways
Betaine, Betanin and Beta vulgaris	Beet root	Inhibition of alcohol induced transcription of pol III, cell growth inhibition, inhibition of cell growth, inhibition of signalling pathways, reduction in CD44+/CD24 count
Quercetin	Red bell pepper, red onion	Apoptosis, cell cycle arrest, induction of PARP cleavage, Bax up-regulation and Bcl 2 down regulation, miR-146a expression regulation, mitochondrial pathways inhibition and activating caspase pathways
Anthocyanin	Red onion	Cell cycle arrest, inhibition of VEGF signalling pathways, angiogenesis

3. Conclusion

The anticancer activity of most important bioactive compounds such as lycopene, β-carotene, myricetin, betaine, quercetin, anthocyanin present in red coloured vegetables such as tomatoes, beetroot, red bell pepper and red onion are studied against various breast cancer cells and the activity was mediated through diverse mechanism of action including cell growth inhibition, cell cycle arrest, inhibition of signalling pathways, suppression of migration and invasion and apoptosis. The bioactive compounds present in red coloured vegetables played a major role as dietary food supplements for various human diseases including cancers. Overall, these bioactive compounds derived from red coloured vegetables are most promising anti cancer bioactive molecules against breast cancer cells.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

References

Aghajanpour, M.; Nazer, M.R.; Obeidavi, Z.; Akbari, M.; Ezati, P. and Kor, N.M. (2017). Functional foods and their role in cancer prevention and health promotion: A comprehensive review. Am. J. Cancer Res., **7**:740-769.

Ahmad, T.; Cawood, M.; Iqbal, Q.; Arino, A.; Batool, A.; Tariq, R.M.S.; Azam, M. and Akhtar, S. (2019). Phytochemicals in *Daucus carota* and their health benefits-review article. Foods, **8**:424 [CrossRef].

Albishi, T.; John, J.A.; Al-Khalifa, A.S. and Shahidi, F. (2013). Antioxidative phenolic constituents of skins of onion varieties and their activities. J. Funct. Foods., **5**(3):1191-1203.

Bae, H.; Jayaprakasha, G.K.; Crosbey, K.; Yoo, K.S.; Leskovar, D. and Patil, B.S. (2014). Ascorbic acid, capsaicinoid, and flavonoid aglycone concentrations as a function of fruit maturity stage in greenhouse-grown peppers. Journal of Food Composition and Analysis, **33**(2): 195-202.

Baghel, S.S.; Shrivastava, N.; Baghel, R.S.; Agrawal, P. and Rajput, S. (2012). A review of quercetin: Antioxidant and anticancer properties. World J. Pharm. Pharm. Sci., **1**:146-160.

Barreto, T.A.; Andrade, S.C.; Maciel, J.F.; Arcanjo, N.M.; Madruga, M.S.; Meireles, B.; Cordeiro, A.M.; Souza, E.L. and Magnani, M. (2016). A chitosan coating containing essential oil from *Origanum vulgare* L. To control postharvest mold infections and keep the quality of cherry tomato fruit. Front. Microbiol., **7**:1724 [CrossRef].

Beynon, R.A.; Richmond, R.C.; Santos Ferreira, D.L.; Ness, A.R.; May, M.; Smith, G.D.; Vincent, E.E.; Adams, C.; Ala-Korpela, M. and Wurtz, P. (2019). Investigating the effects of lycopene and green tea on the metabolome of men at risk of prostate cancer: The ProDiet randomised controlled trial. Int. J. Cancer, **144**:1918-1928. doi: 10.1002/ijc.31929.

Bhadoria, A.S.; Kapil, U.; Sareen, N. and Singh, P. (2013). Reproductive factors and breast cancer: A case-control study in tertiary care hospital of North India. Indian J. Cancer. **50**:316-321, [PubMed].

Bray, F.F.J.; Soerjomataram, I.; Siegel, R.L.; Torre, L.A. and Jemal, A. (2018). GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J. Clin., **68**:394-424, [CrossRef] [PubMed]

Campeau, P.M.; Foulkes, W.D. and Tischkowitz, M.D. (2008). Hereditary breast cancer: New genetic developments, new therapeutic avenues. Hum. Genet., **124**:31-42. [CrossRef] [PubMed].

Campone, L.; Celano, R.; Piccinelli, A.L.; Pagano, I.; Carabetta, S. and Rastrelli, L. (2018). Response surface methodology to optimize supercritical carbon dioxide/co-solvent extraction of brown onion skin by-product as source of nutraceutical compounds, Food Chem., https://doi.org/ 10.1016/j.foodchem.2018.07.042.

Castello, A.;Martìn, M.; Ruiz, A.; Casas, A.M.;Baena- CanÞada, J.M. and Lope, V. (2015). Lower breast cancer risk among women following the World Cancer Research Fund and American Institute for Cancer Research Lifestyle Recommendations: EpiGEICAM Case-Control Study. PLoSOne., **10**(5):1-15. [Crossref].

Cazzaniga, M. and Bonanni, B. (2012) Breast cancer chemoprevention: Old and new approaches. J. Biomed. Biotechnol., **12**:985620. [PubMed].

Challier, B.; Perarnau, J.M. and Viel, J.F. (1998). Garlic, onion and cereal fibre as protective factors for breast cancer: A French case-control study. Eur. J. Epidemiol., **14**:737-47. [PubMed] [Google Scholar.

Charlot, M.; Castro-Webb, N.; Bethea, T.N.; Bertrand, K.; Boggs, D.A.; Denis, G.V.; Adams-Campbell, L.L.; Rosenberg, L. and Palmer, J.R. (2017). Diabetes and breast cancer mortality in Black women. Cancer Cause Control, **28**:61-67, [CrossRef] [PubMed].

Chaudhary, P.; Sharma, A.; Singh, B. and Nagpal, A.K. (2018). Bioactivities of phytochemicals present in tomato. J. Food Sci. Technol., **55**:2833-2849. [CrossRef].

Choe, S.P.; Siah,P.C.; Lim, S.K.; Peh,K.K.; Ong, M.T. and Khoo, B.Y. (2020). The cellular activities of the subfraction of red onion peel crude ethanolic extract in MDA-MB-231 cells. Pharmacogn. Res., **12**:416-423.

Choi, J.A.; Kim, J.Y.; Lee, J.Y.; Kang, C.M.; Kwon, H.J.; Yoo, Y.D.; Kim, T.W.; Lee, Y.S. and Lee, S.J. Induction of cell cycle arrest and apoptosis in human breast cancer cells by quercetin. Int. J. Oncol., **19**:837-844. [CrossRef] [PubMed].

Concha, J.; Weinstein, C. and Zuniga, M.E. (2013). Production of pectic extracts from sugar beet pulp with antiproliferative activity on a breast cancer cell line. Front. Chem. Sci. Eng., **7**:482-489. [CrossRef].

Èrnivec, I.G.O.; Skrt, M.; Šeremet, D.; Sterniša, M.; Farènik, D.; Štrumbelj, E.; Poljanšek, S.; Cebin, N.; Pogaènik, L.; Možina, S.S.; Humar, M.; Komes, D. and Ulrih, N.P. (2021). Waste streams in onion production: Bioactive compounds, quercetin and use of antimicrobial and antioxidative properties. Waste Manag., **126**:476-486, 10.1016/j.wasman.2021.03.033.

Dajas, F. (2012). Life or death: Neuroprotective and anticancer e_ects of quercetin. J. Ethno. Pharmacol., **143**:383-396. [CrossRef] [PubMed].

Du, G.; Lin, H.; Yang, Y.; Zhang, S.; Wu, X.; Wang, M.; Ji, L.; Lu, L.; Yu, L. and Han, G. (2010). Dietary quercetin combining intratumoral doxorubicin injection synergistically induces rejection of established breast cancer in mice. Int. Immunopharmacol., **10**:819-826. [CrossRef] [PubMed].

Duo, J.; Ying, G.G.; Wang, G.W. and Zhang, L. (2012). Quercetin inhibits human breast cancer cell proliferation and induces apoptosis *via* Bcl-2 and Bax regulation. Mol. Med. Rep., **5**:1453-1456. [PubMed].

Eliassen, A.H.; Liao, X.; Rosner, B.; Tamimi, R.M.; Tworoger, S.S. and Hankinson, S.E. (2015). Plasma carotenoids and risk of breast cancer over 20 y of follow-up. Am. J. Clin. Nutr., **101**(6):1197-1205. PMID: 25877493. DOI: 10.3945/ajcn.114.105080.

Etminan, M.; Takkouche, B. and Caamaño-isorna, F. (2004). The role of tomato products and lycopene in the prevention of prostate cancer: A meta-analysis of observational studies. Cancer Epidemiol. Biomark. Prev., **13**:340-345. [PubMed].

Fahmy, S.A.; Ponte, F.;Fawzy, I.M.; Sicilia, E. and Azzazy, H.M.E. (2021). Betaine host-guest complexation with a calixarene receptor: Enhanced *in vitro* anticancer effect. RSC Adv., **11**(40):24673-24680. doi: 10.1039/d1ra04614d.

Farvid, M.S.; Chen,W.Y.; Michels, K.B.; Cho, E.; Willett, W.C. and Eliassen, A.H. (2016). Fruit and vegetable consumption in adolescence and early adulthood and risk of breast cancer: Population based cohort study. BMJ Br. Med. J., pp:353. [CrossRef] [PubMed].

Ferrini, K.; Ghelfi, F.; Mannucci, R. and Titta, L. (2015). Lifestyle, nutrition and breast cancer: Facts and presumptions for consideration. Ecancermedical Science., **9**:1-11. [Crossref].

Fornelli, F.; Leone, A.; Verdesca, I.; Minervini, F. and Zacheo, G. (2007). The influence of lycopene on the proliferation of human breast cell line (MCF-7). Toxicol *In vitro*, **21**(2):217-223.

Gaikwad, S. and Srivastava, S.K. (2021). Role of phytochemicals in perturbation of redox homeostasis in cancer. Antioxidants, **10**:83. [CrossRef] [PubMed].

Gibellini, L.; Pinti, M.; Nasi, M.; Montagna, J.P.; De Biasi, S.; Roat, E.; Bertoncelli, L.; Cooper, E.L. and Cossarizza, A. (2011). Quercetin and cancer chemoprevention. Evid. Based Complement. Alternat. Med., **2011**: 591356. [CrossRef].

Gina, R.M.; Nourhan, S.E.; Gehan,S. and Medhat, W.S. (2022). Enhanced cytotoxic activity of beta carotene conjugated liposomes towards breast cancer cell line: Comparative studies with cyclophosphamide. Anticancer Drugs., **33**(1):e462-e476.doi: 10.1097/CAD.0000000000001245.

Gloria, N.F.; Soares, N.; Brand, C.; Oliveira, F.L.; Borojevic, R. and Teodoro, A.J. (2014). Lycopene and beta-carotene induce cell-cycle arrest and apoptosis in human breast cancer cell lines. Anticancer Res., **4** (3):1377-1386.

Gloria, N.F.; Soares, N.; Brand, C.; Oliveira, F.L.;Borojevic, R. and Teodoro, A.J. (2014). Lycopene and beta-carotene induce cell-cycle arrest and apoptosis in human breast cancer cell lines. Anticancer Res., **34**(3): 1377-86.

Grether-Beck, S.; Marini, A.; Jaenicke, T.; Stahl, W. and Krutmann, J. (2017). Molecular evidence that oral supplementation with lycopene or lutein protects human skin against ultraviolet radiation: Results from a double-blinded, placebo-controlled, Crossover study. Br. J. Dermatol., **176**:1231-1240. [CrossRef].

Grosso, G.; Bella, F.; Godos, J.; Sciacca, S.; Del Rio, D.; Ray, S.; Galvano, F. and Giovannucci, E.L. (2012). Possible role of diet in cancer: Systematic review and multiple meta-analyses of dietary patterns, lifestyle factors, and cancer risk. Nutr. Rev., **75**:405-419. [CrossRef].

He, J.; Gu, Y. and Zhang, S. (2018) Vitamin A and Breast Cancer Survival: A Systematic Review and Meta-analysis. Clin Breast Cancer., **18**(6): e1389-1400. PMID: 30190194. DOI: 10.1016/j.clbc.2018.07.025. [PubMed] [Google Scholar].

Ifesan, B.O.T. (2017). Chemical composition of onion peel (*Allium cepa*) and its ability to serve as a preservative in cooked beef. Int. J. Sci. Res. Methodol., **7**(4):25-34.

Jia, L.; Huang, S.; Yin, X.; Zan, Y.; Guo, Y. and Han, L. (2018). Quercetin suppresses the mobility of breast cancer by suppressing glycolysis through Akt-mTOR pathway mediated autophagy induction. Life Sci., **208**: 123-130. [CrossRef].

Jia, Y.J.; Lu, Y.S.; Wu, K.J.; Lin, Q.; Shen, W.; Zhu, M.J.; Huang, S. and Chen, J. (2013). Does night work increase the risk of breast cancer? A systematic review and meta-analysis of epidemiological studies. Cancer Epidemiol., **37:**197-206. [CrossRef] [PubMed].

Justo, G; de Oliveira, E.M. and Jurberg, C. (2018). Functional foods and cancer on Pinterest and PubMed: Myths and science. Future Sci. OA., **4**: FSO328.

Kapadia, G.J.; Azuine, M.A.; Rao, G.S.; Arai, T.; Iida, A. and Tokuda, H. (2011). Cytotoxic e_ect of the red beetroot (*Beta vulgaris* L.) extract compared to doxorubicin (Adriamycin) in the human prostate (PC-3) and breast (MCF-7) cancer cell lines. Anticancer Agents Med. Chem., **11:**280-284. [CrossRef].

Kashyap, D.; Sharma, A.; Tuli, H.S.; Sak, K.; Punia, S. and Mukherjee, T.K. (2017). Kaempferol: A dietary anticancer molecule with multiple mechanisms of action: Recent trends and advancements. J. Funct. Foods., **30**:203-219. [CrossRef].

Khoo, H.E.; Azlan, A.; Tang, S.T. and Lim, S.M. (2017). Anthocyanidins and anthocyanins: Colored pigments as food, pharmaceutical ingredients, and the potential health benefits. Food Nutr. Res., **61**:1361779. [CrossRef].

Koh, M.S.; Hwang, J.S. and Moon, A.R. (2010). Lycopene inhibits proliferation, invasion and migration of human breast cancer cells. Biomol. Ther., **18**(1):92-98.

Lee, J.; Shin, A.; Oh, J.H. and Kim, J. (2017). Colors of vegetables and fruits and the risks of colorectal cancer. World J. Gastroenterol., **23:** 2527-2538. [CrossRef].

Li ,Y.; Sha Li, Xiao Meng , Ren-You Gan , Jiao-Jiao Zhang and Hua-Bin Li. (2017). Dietary natural products for prevention and treatment of breast cancer. Nutrients, **9:**728; doi:10.3390/nu9070728.

Li X, Xu J, Tang X, Liu Y, Yu X, Wang Z, and Liu W. (2016). Anthocyanins inhibit trastuzumab-resistant breastcancer *in vitro* and *in vivo*. Mol. Med. Rep., **13**(5):4007-13. doi: 10.3892/mmr.2016.4990.

Li, Y.; Li, S.; Meng, X.; Gan, R.Y.; Zhang, J.J. and Li, H.B. (2017). Dietary natural products for prevention and treatment of breast cancer. Nutrients, **9**(7)728doi:10.3390/nu9070728. [PMC free article] [PubMed] [CrossRef] [Google Scholar].

Lim, T.K. (2016). Beta vulgaris. In Edible Medicinal and Non-Medicinal Plants; Lim, T.K., Ed.; Springer: Dordrecht, The Netherlands., **10**:26-68.

Lin, C.W.; Hou, W.C.; Shen, S.C.; Juan, S.H.; Ko, C.H.; Wang, L.M. and Chen, Y.C. (2008). Quercetin inhibition of tumor invasion *via* suppressing PKC /ERK/AP-1-dependent matrix metalloproteinase-9 activation in breast carcinoma cells. CARCIN., **29**:1807-1815. [CrossRef] [PubMed].

Liu, H.; Lee, J.I. and Ahn, T.G. (2019). Effect of quercetin on the antitumor activity of cisplatin in emt6 breast tumor-bearing mice. Obstet. Gynecol. Sci., **62**:242-248. [CrossRef].

Liu, R.; Choi, H.S.; Zhen, X.; Kim, S.L.; Kim, J.H. and Ko, Y.C. (2020). Betavulgarin isolated from sugar beet (*Beta vulgaris*) suppresses breast cancer stem cells through Stat3 signaling. Molecules, **25**:2999.

Ma, H.Y.; Ursin, G.; Xu, X.X.; Lee, E.; Togawa, K.; Duan, L.; Lu, Y.N.; Malone, K.E.; Marchbanks, P.A. and McDonald, J.A. (2017). Reproductive factors and the risk of triple-negative breast cancer in white women and African-American women: A pooled analysis. Breast Cancer Res., pp:19. [CrossRef] [PubMed].

Ma, X. and Ning, S. (2019). Cyanidin-3-glucoside attenuates the angiogenesis of breast cancer *via* inhibiting stat3/vegf pathway. Phytother. Res., **33**:81-89. [CrossRef].

Madia, V.N.; De Vita, D.; Ialongo, D.; Tudino, V.; De Leo, A.; Scipione, L.; Di Santo, R.; Costi, R. and Messore, A. (2021). Recent advances in recovery of lycopene from tomato waste: A potent antioxidant with endless benefits. Molecules, **26**:4495. [CrossRef].

Minich, D.M. (2019). A review of the science of colorful, plant-based food and practical strategies for "eating the rainbow". J. Nutr. Metab., **2019:**2125070.

Moulder, S. and Hortobagyi, G.N. (2008). Advances in the treatment of breast cancer. Clin. Pharmacol. Ther., **83**:26-36. [PubMed].

Nahum, A.; Hirsch, K.; Danilenko, M.; Watts, C.K.; Prall, O.W.; Levy, J. and Sharoni, Y. (2001). Lycopene inhibition of cell cycle progression in breast and endometrial cancer cells is associated with reduction in cyclin D levels and retention of p27Kip1 in the cyclin E-cdk2 complexes. Oncogene, **20**(26):3428.

Nowacki, L.; Vigneron. P.; Rotellini, L.; Cazzola. H.; Merlier. F. and Prost, E. (2015). Betanin-enriched red beetroot (*Beta vulgaris* L.) extract induces apoptosis and autophagic cell death in MCF-7 cells. Phytother. Res., **29**:1964-1973.

Oancea, S.; Radu, M. and Olosutean, H. (2020). Development of ultrasonic extracts with strongantioxidant properties from red onion wastes, 1320-132, Rom. Biotechnol. Lett., **25**(2):https://doi.org/10.25083/rbl/25.2/1320.1327.

Oh, S.J.; Kim, O.; Lee, J.S.; Kim, J.A.; Kim, M.R.; Choi, H.S.; Shim, J.H.; Kang, K.W. and Kim, Y.C. (2010). Inhibition of angiogenesis by quercetin in tamoxifen-resistant breast cancer cells. Food Chem. Toxicol., **48:** 3227-3234.[CrossRef].

Ohno, K. (2020). Secretion of tomatine from tomato roots and analysis of tomatine in the field. Sustain. Humanosph., **16**:55.

Pan American Health Organization. Folha informative Cancer (2018). [cited 10 December 2020].In: PAHO Brazil [Internet].https://www.paho.org/bra/index.php?option=com_ content and view= article and id=5588%20folha-informativa-cancer and Itemid =1094.

Park, S.Y.; Kolonel, L.N.; Lim, U.; White, K.K.; Henderson, B.E. and Wilkens, L.R. (2014). Alcohol consumption and breast cancer risk among women from five ethnic groups with light to moderate intakes: The multiethnic cohort study. Int. J. Cancer, **134**:1504-1510. [CrossRef] [PubMed].

Park, Y.; O'Brien, K.M.; Zhao, S.S.; Weinberg, C.R.; Baird, D.D. and Sandler, D.P. (2017). Gestational diabetes mellitus may be associated with increased risk of breast cancer. Br. J. Cancer, **116**:960-963. [CrossRef] [PubMed].

Pechinskii, S.V. and Kuregyan, A.G. (2014). Molecular-biological problems of drug design and mechanism of drug action. Pharmaceut Chem J., **47**:509-513.

Peng, S.J.; Li, J.; Zhou, Y.; Tuo, M.; Qin, X.X.; Yu, Q.; Cheng, H. and Li, Y.M. (2017). *In vitro* effects and mechanisms of lycopene in mcf-7 human breast cancer cells. Genet. Mol. Res., 16. [CrossRef].

Perveen, R.; Suleria, H.A.R.; Anjum, F.M.; Butt, M.S.; Pasha, I. and Ahmad, S. (2015). Tomato (*Solanum lycopersicum*) carotenoids and lycopenes chemistry; metabolism, absorption, nutrition, and allied health claims: A comprehensive review. Crit. Rev. Food Sci. Nutr., **55:** 919-929. [CrossRef] [PubMed].

Pierobon, M. and Frankenfeld, C.L. (2013). Obesity as a risk factor for triple-negative breast cancers: A systematic review and meta-analysis. Breast Cancer Res. Treat., **137**:307-314. [CrossRef] [PubMed].

Pisu, M.; Demark-Wahnefried, W.;Kenzik, K.; Oster, R.; Lin, C.P. and Manne, S. (2017). A dance intervention for cancer survivors and their partners (RHYTHM). Journal of Cancer Survivorship., **113**:350-359. doi: 10.1007/s11764-016-0593-9 .[PMC free article] [PubMed] [CrossRef] [Google Scholar].

Power, T.E. and Robinson, J. (2006). Cancers related to genetic mutations: Important psychosocial issues for Canadian family physicians. Can. Fam. Physician, **52**:1425-1431.

Puah, B.-P.; Jalil, J.; Attiq, A. and Kamisah, Y. (2021). New insights into molecular mechanism behind anticancer activities of lycopene. molecules, **26**:3888. [CrossRef] [PubMed].

Ranganathan, S.; Halagowder, D. and Sivasithambaram, N.D. (2015). Quercetin suppresses twist to induce apoptosis in MCF-7 breast cancer cells. PLoS ONE., 10: e0141370. [CrossRef].

Rao, A.V. and Rao, L.G. (2007). Carotenoids and human health. Pharmacol. Res., **55**:207-216. doi: 10.1016/j.phrs. 2007, 01, 012. [PubMed] [CrossRef] [Google Scholar].

Rauf, A.; Imran, M.; Khan, I.A.; ur-Rehman, M.; Gilani, S.A.; Mehmood, Z. and Mubarak, M.S. (2018). Anticancer potential of quercetin: A comprehensive review. Phytother. Res., **32**:2109-2130. [CrossRef] [PubMed].

Rieder, V.; Salama, M.; Glockner, L.; Muhr, D.; Berger, A.; Tea, M.K.; Pfeiler, G.; Rappaport-Fuerhauser, C.; Gschwantler-Kaulich, D. and Weingartshofer, S. (2016). Effect of lifestyle and reproductive factors on the onset of breast cancer in female BRCA 1 and 2 mutation carriers. Mol. Genet. Genom. Med., **4:**172-177. [CrossRef] [PubMed].

Rivera, A.R.; Castillo-Pichardo, L.; Gerena, Y. and Dharmawardhane, S. (2016). Antibreast cancer potential of quercetin *via* the Akt/AMPK/ mammalian target of rapamycin (mTOR) signaling cascade. PLoS ONE, **11:** e0157251. [CrossRef] [PubMed].

Saini, R.K.; Nile, S.H. and Park, W. (2015). Carotenoids from fruits and vegetables: Chemistry, analysis, occurrence, bioavailability and biological activities. Food Res Int., **76**:735-750.

Seo, H.S.; Ku, J.M.; Choi, H.S.; Choi, Y.K.; Woo, J.K.; Kim, M.; Kim, I.; Na, C.H.; Hur, H. and Jang, B.H. (2016). Quercetin induces caspase-dependent extrinsic apoptosis through inhibition of signal transducer and activator of transcription 3 signaling in HER2-overexpressing BT-474 breast cancer cells. Oncol. Rep., **36**:31-42. [CrossRef] [PubMed].

Serrati, S.; Porcelli, L.; Guida, S.; Ferretta, A.; Iacobazzi, R.M.; Cocco, T.; Maida, I.; Tamasi, G.; Rossi, C. and Manganelli, M. (2020). Tomatine displays antitumor potential in *in vitro* models of metastatic melanoma. Int. J. Mol. Sci., **21:**5243. [CrossRef].

Shree, G.S.; Prasad, K.Y.; Arpitha, H.S.; Deepika, U.R.; Kumar, K.N.; Mondal, P. and Ganesan, P. (2017). α-carotene at physiologically attainable concentration induces apoptosis and down-regulates cell survival and antioxidant markers in human breast cancer (MCF-7) cells. Mol. Cell. Biochem., **436**:1-12. [Google Scholar] [CrossRef].

Sisti, J.S.; Collins, L.C.; Beck, A.H.; Tamimi, R.M.; Rosner, B.A. and Eliassen, A.H. (2016). Reproductive risk factors in relation to molecular subtypes of breast cancer: Results from the nurses' health studies. Int. J. Cancer., **138:**2346-2356. [CrossRef] [PubMed].

Soerjomataram, I.; Oomen, D.; Lemmens, V.; Oenema, A.; Benetou, V.; Trichopoulou, A.; Coebergh, J.W.; Barendregt, J. and de Vries, E. (2010). Increased consumption of fruit and vegetable and future cancer incidence in selected European countries. Eur. J. Cancer., **46**:2563-2580. [CrossRef] [PubMed].

Soleimani, M. and Sajedi, N. (2020). Myricetin apoptotic effects on t47d breast cancer cells is a p53-independent approach. Asian Pac. J. Cancer Prev 2020, **21**:3697-3704. [CrossRef].

Sowmya Shree, G.; Yogendra Prasad, K.; Arpitha, H.S.; Deepika, U.R.; Nawneet Kumar, K.; Mondal, P. and Ganesan, P. (2017). Beta-carotene at physiologically attainable concentration induces apoptosis and down-regulates cell survival and antioxidant markers in human breast cancer (mcf-7) cells. Mol. Cell Biochem., **436**:1-12. [CrossRef] [PubMed].

Srinivasan, A.; Thangavel, C.; Liu, Y.; Shoyele, S.; Den, R.B.; Selvakumar, P. and Lakshmikuttyamma, A. (2016). Quercetin regulates beta-catenin signaling and reduces the migration of triple negative breast cancer. Mol. Carcinog., **55**:743-756. [CrossRef] [PubMed].

Takeshima, M.; Ono, M.; Higuchi, T.; Chen, C.; Hara, T. and Nakano, S. (2014). Anti-proliferative and apoptosis-inducing activity of lycopene against three subtypes of human breast cancer cell lines. Cancer Sci., **105**(3):252-257. doi: 10.1111/cas.12349.

Tan, G.; Gyllenhaal, C. and Soejarto, D. (2006). Biodiversity as a source of anticancer drugs. Curr. Drug Targets, **7**:265-277. [CrossRef].

Tao, S.F.; He, H.F. and Chen, Q. (2015). Quercetin inhibits proliferation and invasion acts by up-regulating miR-146a in human breast cancer cells. Mole. Cell. Biochem., **402:**93-100. [CrossRef].

Turati, F.; Rossi, M.; Pelucchi, C.; Levi, F. and La Vecchia, C. (2015). Fruit and vegetables and cancer risk: A review of southern European studies. Br. J. Nutr., **113**:102-110. [CrossRef] [PubMed].

Uppala, P.T.;Dissmore, T.; Lau, B.H.; Andacht, T. and Rajaram, S. (2013). Selective inhibition of cell proliferation by lycopene in MCF-7 breast cancer cells *in vitro*: A proteomic analysis. Phytother Res., **27**(4):595-601.

Valderas-Martinez, P.; Chiva-Blanch, G.; Casas, R.; Arranz, S.; Martinez-Huelamo, M.; Urpi-Sarda, M.; Torrado, X.; Corella, D.; Lamuela-Raventos, R.M. and Estruch, R. (2016). Tomato sauce enriched with olive oil exerts greater effects on cardiovascular disease risk factors than raw tomato and tomato sauce: A randomized trial. Nutrients, **8:**170. [CrossRef] [PubMed].

Voskuil, D.W.; Vrieling, A.; Korse, C.M.; Beijnen, J.H.; Bonfrer, J.M.G.; van Doorn, J.; Kaas, R.; Oldenburg, H.S.A.; Russell, N.S. and Rutgers, E.J.T. (2008). Effects of lycopene on the insulin-like growth factor (IGF) system in premenopausal breast cancer survivors and women at high familial breast cancer risk. Nutr. Cancer, **60**:342-353. [CrossRef] [PubMed].

Wang, F. and Yang, Y. (2014). Quercetin suppresses insulin receptor signaling through inhibition of the insulin ligand-receptor binding and therefore impairs cancer cell proliferation. Biochem. Biophys. Res. Commun., **452:**1028-1033. [CrossRef] [PubMed].

Yu, S.; Li, H.; Cui, T.; Cui, M.; Piao, C.; Wang, S.; Ju, M.; Liu, X.; Zhou, G.; Xu, H. and Li, G. (2021). Onion (*Allium cepa* L.) peel extract effects on 3T3-L1 adipocytes and high-fat diet-induced obese mice. Food Biosci., **41:** Article 101019, 10.1016/j.fbio.2021.101019.

Zhang, J.J.; Li, Y.; Zhou, T.; Xu, D.P.; Zhang, P.; Li, S. and Li, H.B. (2016). Bioactivities and health benefits of mushrooms mainly from China. Molecules, **21:** 938. [CrossRef] [PubMed].

Zhang, Q.; Pan, J.; Wang, Y.; Lubet, R. and You, M. (2013). Beetroot red (Betanin) inhibits vinyl carbamate and benzo(a)pyrene-induced Lung tumorigenesis through apoptosis. Mol. Carcinog., **52**:686-691. [CrossRef].

Zhao, X.; Wang, Q.; Yang, S.; Chen, C.; Li, X.; Liu, J.; Zou, Z. and Cai, D. (2016). Quercetin inhibits angiogenesis by targeting calcineurin in the xenograft model of human breast cancer. Eur. J. Pharmacol., **781:** 60-68. [CrossRef] [PubMed].

Zheng, J.; Zhou, Y.; Li, Y.; Xu, D.P.; Li, S. and Li, H.B. (2016). Spices for prevention and treatment of cancers. Nutrients, **8**:495. [CrossRef] [PubMed].

Zhou, Y.; Zheng, J.; Li, Y.; Xu, D.P.; Li, S.; Chen, Y.M. and Li, H.B. (2016). Natural polyphenols for prevention andtreatment of cancer. Nutrients, **8**: 515. [CrossRef] [PubMed].

Zhou, Z.; Mao,W.; Li, Y.; Qi, C. and He, Y. (2019). Myricetin inhibits breast tumor growth and angiogenesis by regulating vegf/vegfr2 and p38mapk signaling pathways. Anat. Rec., **302**:2186-2192.

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