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A Comprehensive Review on Breast Cancer: Introduction, History, Symptoms, Diagnosis, Treatment, and the Role of Medicinal Plants

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***Abstract*--Breast cancer is a significant global health concern, affecting millions of women and men worldwide. This review paper explores the introduction, historical background, symptoms, diagnosis, and treatment options for breast cancer, with a focus on the role of medicinal plants in cancer care. The conventional treatments like surgery, chemotherapy, and radiation remain the mainstay for managing breast cancer, complementary therapies involving medicinal plants are gaining attention due to their potential to support cancer treatment and reduce associated side effects. This paper discusses both conventional and plant-based approaches, evaluating their effectiveness, safety, and potential synergy in improving patient outcomes (Figure 1).**

***Keywords*-- Breast Cancer, Shape, Diagnosis, Surgery, Medicinal Plants**

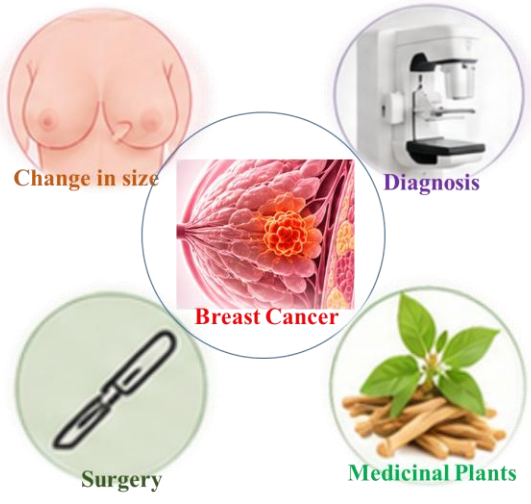

Figure 1: Breast Cancer: Symptoms, Diagnosis, Treatment, and the Role of Medicinal Plants

I. Introduction

Breast cancer is one of the most prevalent types of cancer, particularly among women, and represents a major cause of morbidity and mortality worldwide [1-3]. According to the World Health Organization (WHO), breast cancer accounts for about 25% of all cancer diagnoses in women and is the second leading cause of cancer-related deaths globally [4, 5]. Although advancements in early detection and treatment have significantly improved survival rates, breast cancer remains a complex disease with various subtypes, each requiring tailored therapeutic strategies [6, 7].

The treatment of breast cancer typically involves a combination of surgery, chemotherapy, radiation, and, more recently, targeted therapies and immunotherapies [8, 9]. However, the side effects of conventional therapies, such as nausea, fatigue, hair loss, and immunosuppression, can significantly impact patients' quality of life [10, 11]. In this context, medicinal plants are being increasingly explored for their potential to alleviate symptoms, support immune function, and improve the effectiveness of conventional treatments [12].

This review paper provides an overview of breast cancer, its historical context, common symptoms, diagnostic methods, and treatment options, while also highlighting the growing interest in medicinal plants for cancer care.

II. History Of Breast Cancer

The history of breast cancer dates back thousands of years, with ancient civilizations recognizing the disease in various forms [13, 14]. The earliest recorded references to breast cancer are found in Egyptian papyri from around 1600 BCE, which describe the disease as a lump in the breast [13, 15, 16].

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The Greek physician Hippocrates (460-370 BCE) is believed to have coined the term karkinos, meaning crab, to describe tumors due to their crab-like appearance [15, 17]. Throughout history, breast cancer has often been associated with poor prognosis, as little could be done to treat it.

In the 19th century, the advent of surgical intervention marked a turning point in the treatment of breast cancer [18, 19]. William Halsted revolutionized breast cancer surgery with the development of the radical mastectomy in the late 1800s [20, 21]. This procedure involved the removal of the entire breast, underlying chest muscles, and surrounding lymph nodes [22, 23]. While effective in removing visible tumors, it often resulted in significant physical and psychological consequences for patients.

In the 20th century, advances in diagnostic techniques such as mammography, combined with the development of more conservative surgical approaches like lumpectomy, revolutionized breast cancer treatment [24, 25]. The discovery of the role of hormones in the progression of breast cancer led to the introduction of hormone therapy, and the development of targeted therapies has further enhanced the ability to treat specific cancer subtypes [26, 27].

Today, with ongoing advancements in research and clinical practice, breast cancer is no longer considered a uniformly fatal disease. Early detection, targeted therapies, and personalized treatment plans have dramatically improved survival rates and quality of life for many patients.

III. Symptoms Of Breast Cancer

Breast cancer can present with a variety of symptoms, though early stages may be asymptomatic, underscoring the importance of regular screening (Figure 2).

Figure 2: Comparative symptoms of breast cancer.

Lump in the Breast: The most common symptom of breast cancer is a painless lump in the breast or underarm. While not all lumps are cancerous, any new lump should be evaluated [28-30]. This lump forms when abnormal cells grow uncontrollably, creating a cluster of tissue.

These lumps are typically hard, have irregular edges, and do not move easily, although some cancerous lumps can be soft, round, or tender to the touch [31, 32]. A lump may be detected during a routine self-examination, a clinical breast exam, or a screening mammogram, even if it cannot be felt by hand [33, 34]. It is important to remember that not all breast lumps are cancerous; many can result from non-cancerous conditions such as cysts, fibroadenomas, infections, or hormonal changes [35-37].

Changes in Breast Size, Shape, and Appearance: A noticeable change in breast size or shape can be a significant warning sign of breast cancer, especially if the change affects only one breast and is unrelated to normal hormonal fluctuations, pregnancy, or aging [38-40]. As a tumor grows, it can alter the breast's appearance, leading to swelling, deformity, or asymmetry. In some cases, the breast skin may become red, thickened, or warm to the touch; additionally, the tumor can pull on internal connective tissues, causing dimpling or puckering of the skin [41-43]. A specific symptom, known in French known as 'peau d'orange' (orange peel), occurs when the skin develops small pits and becomes rough and thickened, resembling the surface of an orange; this happens when cancer blocks lymphatic vessels in the skin, causing fluid accumulation and swelling [41, 44-46].

Nipple Changes: Changes in the nipple and the surrounding skin can be important signs of breast cancer; if these changes are new or persistent, they should be medically evaluated. Nipple inversion, where the nipple retracts inward, can occur if a tumor beneath the nipple shortens the milk ducts or pulls them inward [47-49]. Changes to the skin around the nipple such as redness, crusting, scaling, thickening, or persistent irritation may indicate an underlying breast issue. In some cases, these changes can be associated with specific types of breast cancer, such as Paget's disease of the breast [50-53]. Unexplained nipple discharge, especially if it occurs suddenly from one breast and contains blood or traces of blood, is another warning sign requiring immediate medical attention [54, 55].

Pain or Tenderness: Breast cancer typically does not cause pain in the early stages; some women may experience tenderness, general pain, or discomfort in the breast or underarm area [56, 57]. Pain associated with breast cancer can vary in intensity and may be constant or intermittent, though it is less common than symptoms such as a painless lump or changes in the breast or nipple [58-60]. In many cases, breast pain arises from causes other than cancer, such as hormonal changes related to menstruation, breast cysts, infections, muscle strain, or non-cancerous breast conditions [61-63].

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Swelling in the Armpit or Collarbone Area: Swelling or hardening of lymph nodes in the axilla, above the collarbone, or near the breastbone can indicate that breast cancer has spread to nearby lymph nodes [64, 65]. Lymph nodes are small, bean-shaped components of the body's immune system that help filter out harmful substances, including cancer cells. When breast cancer spreads beyond the primary tumor, it often reaches nearby nodes first via the lymphatic system [66-69]. This causes the nodes to become enlarged and hard and sometimes fixed in place, whereas they are typically soft and movable. In some cases, swelling in the lymph nodes may be noticed even before a lump in the breast is detected [70-72]. However, enlarged lymph nodes are not always caused by cancer; they can also result from infections, inflammation, or other medical conditions.

It is important to note that these symptoms can also be caused by benign conditions, such as cysts, fibroids, or infections, which is why prompt medical evaluation is crucial.

II. DIAGNOSIS OF BREAST CANCER

The diagnosis of breast cancer is based on a combination of clinical evaluations, imaging tests, and histopathological analysis.

Clinical Examination

A clinical breast exam (CBE) by a healthcare provider can help detect lumps, changes in breast tissue, and signs of abnormal lymph nodes (Figure 3). It is usually performed as part of routine health check-ups [73-76].

Imaging Tests

Mammography: The primary tool for screening and diagnosing breast cancer, mammography uses low-dose X-rays to identify abnormal masses or calcifications in the breast tissue [77-80].

Ultrasound: This imaging technique is often used to distinguish between solid tumors and fluid-filled cysts. It is commonly used for further investigation after an abnormal mammogram [81-83].

Magnetic Resonance Imaging (MRI): MRI is more sensitive than mammography and can be used for high-risk patients or in cases where the mammogram results are inconclusive. It provides detailed images of the breast tissue and is especially useful in detecting tumors in dense breast tissue [84-86].

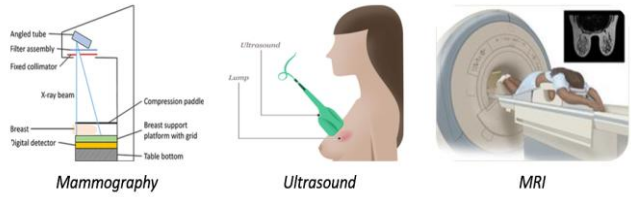

Figure 3: Imaging examination of breast cancer.

Biopsy

A biopsy is the most reliable and definitive method for detecting breast cancer, as it allows doctors to confirm the presence or absence of cancer cells by examining breast tissue under a microscope [87-91]. During this procedure, a small tissue sample is removed from a suspicious area identified through imaging or physical examination [92, 93]. There are several types of breast biopsies, such as Fine Needle Aspiration Biopsy (FNAB), which uses a thin needle to extract cells or fluid [94, 95]; Core Needle Biopsy (CNB), which uses a larger needle to remove a small cylinder (core) of tissue for detailed analysis (Figure 4) [96-98]; and Incisional Biopsy (IB), a surgical procedure where a portion of the suspicious lump is removed when needle biopsies fail to provide sufficient information [99-100]. Biopsy results provide the most accurate data, helping to determine whether the tissue is benign (non-cancerous) or malignant (cancerous) [101].

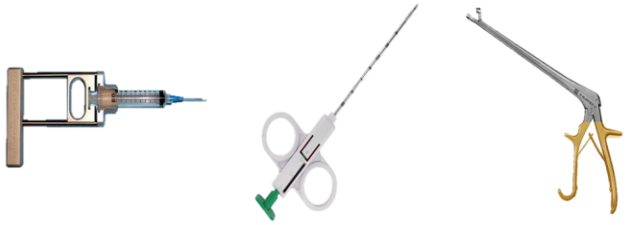

Figure 4: Biopsy tools used sample collection for microscopic examination of breast cancer.

Genetic Testing

Genetic testing plays a crucial role in identifying individuals at high risk for hereditary breast cancer, particularly those with a family history of the disease [102-104]. These tests detect mutations in genes such as BRCA-1 (65-80%) and BRCA-2 (45-70%), which normally help repair damaged DNA and prevent tumor formation [105-108].

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When harmful mutations are present, the risk of breast cancer especially regarding hereditary disease and early-onset cases is significantly higher compared to the general population [109, 110]. Identifying these genetic mutations enables patients and their family members to make informed decisions regarding personalized screening strategies, preventive measures, and risk-reducing treatments (Figure 5).

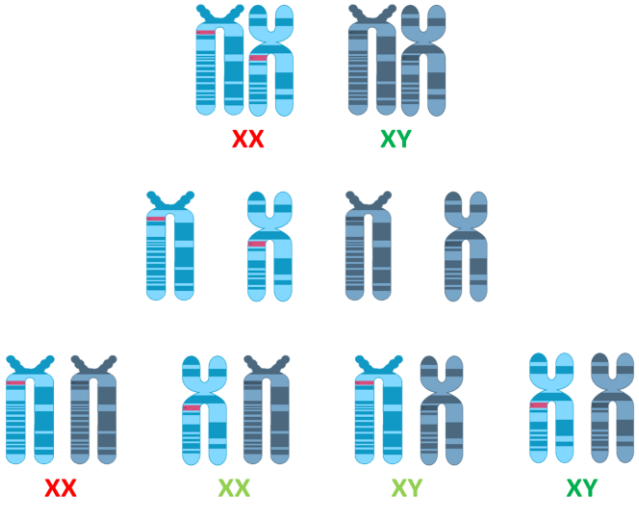

Figure 5: Genetic testing high risk for hereditary breast cancer.

IV. Treatment Of Breast Cancer

The treatment of breast cancer depends on its type, stage, and molecular characteristics, as well as the patient's general health. Standard treatment options include:

Surgery

Lumpectomy: Involves removing the tumor and a small margin of surrounding tissue, leaving the breast intact. It is typically followed by radiation therapy [111, 112].

Mastectomy: Involves the removal of one or both breasts. There are different types of mastectomies, including simple mastectomy, modified radical mastectomy, and radical mastectomy, depending on the extent of tissue removal [113, 114].

Sentinel Lymph Node Biopsy: This involves removing the first few lymph nodes that drain the breast to check for cancer spread [115, 116].

Chemotherapy

Chemotherapy uses powerful drugs to kill cancer cells or stop their growth. It is often used after surgery as adjuvant therapy to reduce the risk of recurrence, or before surgery as neoadjuvant therapy to shrink tumors [117-119].

Radiation Therapy

Radiation therapy uses high-energy rays to kill cancer cells. It is typically used after surgery to destroy any remaining cancer cells, especially in cases where a lumpectomy has been performed [115, 120].

Hormonal Therapy

For hormone receptor-positive breast cancers, hormonal therapy is used to block the hormones estrogen or progesterone that fuel the growth of the cancer. Drugs such as tamoxifen and aromatase inhibitors are commonly used in treatment [121-122].

Targeted Therapy

Targeted therapies are drugs that target specific molecules involved in cancer growth. For example, HER-2-positive breast cancers are treated with drugs like trastuzumab (Herceptin), which target the HER-2 protein on cancer cells [123-125].

Immunotherapy

Immunotherapy works by enhancing the body's immune system to fight cancer. It is particularly used for aggressive subtypes like triple-negative breast cancer, which do not respond to hormone therapy or targeted therapies [126-128].

V. Medicinal Plants Roleplay In Breast Cancer

While conventional treatments form the backbone of breast cancer therapy, there is growing interest in the role of medicinal plants and natural compounds in cancer treatment. Many plants possess anti-inflammatory, antioxidant, anti-cancer, and immunomodulatory properties that can support cancer treatment and improve patient outcomes.

Garlic is a significant medicinal plant, the bulbs or cloves of which contain a bioactive sulfur compound known as Allicin. This compound is formed from Alliin through enzymatic action when garlic tissues are crushed or cut. Allicin has garnered considerable attention due to its potential anticancer properties, particularly in the field of breast cancer research. The studies have demonstrated that Allicin can inhibit tumor growth by inducing apoptosis, suppressing the proliferation of cancer cells, mitigating oxidative stress, blocking angiogenesis, and interfering with metastatic pathways. In breast cancer cell lines such as MCF-7 and MDA-MB-231, Allicin and organosulfur compounds derived from garlic have exhibited cytotoxic and anti-proliferative effects by modulating various signaling pathways, including NF-κB, MAPK, and caspase activation.

Garlic also possesses antioxidant and anti-inflammatory properties, which may be instrumental in protecting against carcinogenesis and tumor progression [129-131].

Aloe Vera is a widely utilized medicinal plant; the gel extracted from its leaves contains numerous biologically active compounds, notably Aloin and Emodin, whose anti-cancer effects, including those against breast cancer, have been the subject of research. Aloe Vera gel is rich in anthraquinones, polysaccharides, vitamins, enzymes, and phenolic compounds, which exhibit antioxidant, anti-inflammatory, immunomodulatory, and cytotoxic activities. Studies have demonstrated that Aloin and Aloe-Emodin can inhibit the proliferation of tumor cells by inducing apoptosis within cancer cells, arresting the cell cycle, generating reactive oxygen species (ROS), and modulating signaling pathways such as p53, NF-κB, and MAPK. In breast cancer cell lines such as MCF-7 and MDA-MB-231, compounds derived from Aloe Vera have demonstrated the capacity to suppress cancer cell growth and reduce metastatic activity. Aloe Vera has also been explored as an adjunctive therapy for cancer patients to mitigate side effects associated with chemotherapy, enhance wound-healing processes, and bolster immune responses [132-134].

Annona muricata, commonly known as Soursop or Graviola, is a tropical medicinal plant. Its leaves and fruits contain a unique class of bioactive compounds known as Acetogenins. Their anti-cancer properties, particularly their activity against breast cancer cell lines, have been extensively studied. Acetogenins, such as Annonacin, Annomuricin, and Muricin, are known to inhibit mitochondrial Complex I; as a result, they reduce ATP production in cancer cells and induce apoptosis. The studies utilizing breast cancer cell lines such as MCF-7 and MDA-MB-231 have demonstrated that extracts derived from *Annona muricata* leaves can reduce cell proliferation, induce programmed cell death, arrest the cell cycle, and suppress metastatic activity by modulating various signaling pathways, including Bax/Bcl-2, caspases, and oxidative stress responses. This plant also possesses antioxidant and anti-inflammatory properties, which may aid in inhibiting the process of tumor growth [135-137].

Neem, known as *Azadirachta indica,* is a significant medicinal tree widely utilized in traditional medicine. Its leaves and bark contain numerous biologically active compounds, particularly Nimbolide, whose anti-cancer effects have been extensively studied, including its potential in the prevention and treatment of breast cancer. Nimbolide, a Limonoid-type Triterpene, has demonstrated significant antiproliferative, antioxidant, anti-inflammatory, and pro-apoptotic activities across various cancer models.

Studies conducted on breast cancer cell lines such as MCF-7 and MDA-MB-231 have revealed that Neem extracts and Nimbolide can inhibit the proliferation of tumor cells by inducing apoptosis; specifically, by activating caspases, disrupting mitochondrial membrane potential, suppressing NF-κB signaling, and modulating Bax/Bcl-2 pathways. Compounds derived from Neem are also known to arrest the cell cycle, inhibit angiogenesis and metastasis, and mitigate oxidative stress associated with tumor progression. In animal studies, Neem extracts have demonstrated the capacity to suppress tumor growth and enhance immune responses, thereby indicating their potential role as adjuvant anti-cancer agents [138-140].

Camellia sinensis, commonly known as green tea, is a plant of medicinal significance whose leaves are rich in polyphenolic compounds, specifically epigallocatechin-3-gallate (EGCG) and other catechins, which have demonstrated significant antioxidant and anti-tumor activities in breast cancer research. EGCG is considered the primary bioactive constituent responsible for many of green tea's anti-cancer effects, including the inhibition of cancer cell proliferation, the induction of apoptosis, the suppression of angiogenesis, and the prevention of metastasis. The studies utilizing breast cancer cell lines such as MCF-7 and MDA-MB-231 have revealed that EGCG can modulate various molecular signaling pathways, including PI3K/Akt, MAPK, NF-κB, and p53, thereby reducing tumor growth and promoting programmed cell death. The polyphenols found in green tea exhibit potent antioxidant activity by scavenging reactive oxygen species and mitigating oxidative stress, which plays a pivotal role in carcinogenesis. EGCG disrupts estrogen receptor-mediated signaling and downregulates the expression of proteins involved in cell cycle progression and invasiveness of breast cancer cells [141-143].

Catharanthus roseus, commonly known as the Madagascar periwinkle or simply periwinkle, is an extremely valuable medicinal plant. Its leaves contain the significant indole alkaloids Vincristine and Vinblastine, two clinically important anticancer drugs widely used in the chemotherapy of various cancers, including breast cancer, leukemia, Hodgkin lymphoma, and lung cancer. These alkaloids exhibit potent antitumor activity by binding to tubulin proteins and inhibiting microtubule assembly during mitosis; this arrests cell division at the metaphase stage and induces apoptosis in rapidly proliferating cancer cells. Vincristine primarily interferes with mitotic spindle assembly, while vinblastine suppresses microtubule polymerization and disrupts cellular replication pathways.

Studies conducted on breast cancer cell lines have demonstrated that these compounds inhibit tumor cell proliferation and metastatic progression through the modulation of cell cycle regulatory proteins and apoptotic signaling pathways. The discovery of vincristine and vinblastine from *Catharanthus roseus* marked a significant milestone in plant-derived chemotherapy and remains one of the most successful examples of natural product-based anticancer drug development [144-146].

Curcuma longa, commonly known simply as turmeric, is a widely utilized medicinal plant. Its rhizome contains the polyphenolic compound Curcumin, which is renowned for its potent anti-inflammatory, antioxidant, and anti-cancer properties, particularly against breast cancer. Curcumin's ability to inhibit the proliferation of breast cancer cells has been extensively studied. It achieves this through various molecular mechanisms, including the induction of apoptosis, the suppression of cell proliferation, the inhibition of angiogenesis and metastasis, and the modulation of signaling pathways such as NF-κB, PI3K/Akt, STAT3, MAPK, and p53. The studies utilizing breast cancer cell lines such as MCF-7, MDA-MB-231, and HER2-positive cells have demonstrated that curcumin can arrest the cell cycle, activate caspase-mediated apoptosis, and downregulate inflammation-related mediators associated with tumor progression. Curcumin also possesses potent antioxidant properties, which aid in preventing chronic inflammation and carcinogenesis linked to cancer development by scavenging reactive oxygen species and mitigating oxidative stress. Curcumin has demonstrated the capacity to enhance the efficacy of chemotherapy and radiotherapy while simultaneously reducing treatment-related toxicity; thus, it has established itself as a promising adjuvant therapeutic agent in the management of breast cancer [147-149].

The ***Peepal*** tree, commonly known as *Ficus religiosa,* is a traditional medicinal plant whose leaves contain a diverse array of phytochemicals such as flavonoids, tannins, sterols, and phenolic compounds. The anti-cancer activities of these compounds have been investigated, particularly regarding their effects on breast cancer cell lines. The studies have demonstrated that extracts from *Ficus religiosa* leaves have cytotoxic and antiproliferative effects; they inhibit the growth of cancer cells through various mechanisms, including the induction of apoptosis, the disruption of mitochondrial membrane potential, the enhancement of oxidative stress within tumor cells, and the modulation of signaling pathways involved in cell survival and proliferation, such as caspases, p53, and NF-κB.

The studies conducted on breast cancer cell lines, specifically MCF-7 and MDA-MB-231, indicate that Peepal leaf extracts can reduce cell viability and suppress processes associated with tumor progression, such as invasion and metastasis, the spread to other parts of the body. This plant is also recognized for its antioxidant and anti-inflammatory properties; these attributes may play a protective role against carcinogenesis by neutralizing free radicals and mitigating chronic inflammation associated with tumor development [150-152].

Moringa oleifera, commonly known as the Moringa or drumstick tree, is a highly nutritious medicinal plant. Its leaves and seeds are rich in bioactive compounds such as Isothiocyanates, flavonoids, phenolic acids, vitamins, and minerals. These compounds contribute to its potent antioxidant and potential anti-tumor properties, including its relevance in breast cancer research. Isothiocyanates, derived from the glucosinolates found in Moringa, exert anti-cancer effects by inducing apoptosis, inhibiting the proliferation of cancer cells, modulating oxidative stress, and suppressing inflammation-related signaling pathways such as NF-κB and MAPK. The studies conducted on breast cancer cell lines such as MCF-7 and MDA-MB-231 have demonstrated that extracts from Moringa leaves and seeds can reduce cell viability, arrest the cell cycle, and induce programmed cell death by activating caspases and regulating pro- and anti-apoptotic proteins like Bax and Bcl-2. The plant's high antioxidant potential plays a protective role by scavenging reactive oxygen species and mitigating DNA damage associated with carcinogenesis. The ability of Moringa compounds to inhibit angiogenesis, the formation of new blood vessels, and metastasis has also been investigated, highlighting their comprehensive anti-tumor potential [153-155].

Nardostachys jatamansi, commonly known as Jatamansi, is a medicinal herb. Its rhizomes and roots are rich in sesquiterpenes, volatile oils such as jatamansone or nardostachone, lignans, and flavonoids. Its potential anti-cancer effects have been investigated in breast cancer models. The studies suggest that Jatamansi extracts may exert anti-cancer effects by inducing apoptosis in cancer cells, arresting the cell cycle, reducing oxidative stress, and modulating key signaling pathways involved in tumor growth, such as mitochondria-dependent caspase activation and the regulation of Bax/Bcl-2 expression. In studies involving breast cancer cell lines, Jatamansi extracts have demonstrated cytotoxic-like cell-killing effects, resulting in reduced cell viability and inhibited proliferation.

This is attributed to its antioxidant and anti-inflammatory properties, which help suppress cancer-promoting processes. While the plant's neuroprotective, brain-protecting, and adaptogenic properties are well-established in traditional medicine, its anti-cancer potential is now being explored more extensively, given its capacity to influence various molecular targets involved in tumor growth and survival [156-158].

Nigella sativa, commonly known as black cumin, is a medicinal plant whose seeds contain a bioactive compound called Thymoquinone. Extensive research has been conducted on its anti-cancer and anti-proliferative properties, including its relevance in breast cancer research. Thymoquinone is the plant's primary medicinally active constituent, responsible for many of its therapeutic effects, such as antioxidant, anti-inflammatory, and apoptosis-inducing activities. In breast cancer cell lines such as MCF-7 and MDA-MB-231, Thymoquinone has demonstrated the ability to inhibit cell proliferation, induce apoptosis, and suppress tumor growth. It achieves this by modulating several molecular pathways, including p53 activation, stimulation of the caspase cascade, downregulation of NF-κB signaling, and inhibition of the PI3K/Akt and STAT3 pathways. It also mitigates oxidative stress by scavenging Reactive Oxygen Species (ROS) and prevents DNA damage, thereby contributing to its chemopreventive potential. The studies indicate that Thymoquinone can inhibit angiogenesis, the formation of new blood vessels, and metastasis processes critical for the dissemination of tumors throughout the body; it accomplishes this by reducing the expression of Vascular Endothelial Growth Factor (VEGF) and Matrix Metalloproteinases (MMPs) [159-161].

Tulsi, *Ocimum tenuiflorum*, commonly known as Holy Basil, is a significant medicinal plant whose leaves contain bioactive compounds such as Eugenol, Ursolic acid, Rosmarinic acid, and various flavonoids that contribute to its potent antioxidant, anti-inflammatory, and potential anticancer properties. Eugenol and Ursolic acid have been extensively studied for their cytotoxic and antiproliferative effects against cancer cells, including breast cancer models such as MCF-7 and MDA-MB-231. The studies have demonstrated that these compounds induce apoptosis, inhibit cell proliferation, and suppress tumor progression by modulating signaling pathways, including NF-κB, PI3K/Akt, MAPK, and caspase-dependent apoptotic cascades. The antioxidant activity of Tulsi leaves helps neutralize reactive oxygen species, thereby potentially reducing the risk of oxidative DNA damage and carcinogenesis.

It has been reported that Ursolic acid inhibits angiogenesis and metastasis by downregulating matrix metalloproteinases (MMPs) and vascular endothelial growth factor (VEGF), thereby contributing to its antitumor potential. The studies also suggest that it possesses immunomodulatory effects capable of enhancing the host's defense against tumor growth [162-164].

Panax ginseng, commonly known as ginseng, is a medicinal plant that has been the subject of extensive research. Its roots contain active triterpene saponins, referred to as Ginsenosides. These Ginsenosides are primarily responsible for their medicinal and anti-cancer properties, including potential effects against breast cancer. Ginsenosides such as Rg3, Rh2, and compound K have demonstrated significant anti-proliferative and pro-apoptotic effects in breast cancer cells, specifically MCF-7 and MDA-MB-231. These compounds halt the cell cycle and induce programmed cell death by modulating various signaling pathways, including PI3K or Akt, MAPK, NF-κB, and p53. These compounds suppress tumor growth by inhibiting angiogenesis, the formation of blood vessels, reducing the metastatic potential of cancer cells by lowering levels of matrix metalloproteinases (MMPs), and regulating estrogen receptor-mediated signaling in hormone-dependent breast cancers. Ginsenosides possess antioxidant and immunomodulatory properties, which help to mitigate oxidative stress and bolster the body's defense mechanisms against tumor progression [165-167].

Phyllanthus amarus, commonly known as Bhui Amla, is a medicinal herb containing various bioactive constituents distributed throughout the entire plant. These include lignans such as phyllanthin and hypophyllanthin, flavonoids, tannins, and polyphenols. These constituents contribute to its cytotoxic and potential anti-cancer properties, including effects observed in breast cancer cell models. The studies have demonstrated that extracts of *Phyllanthus amarus* exhibit antiproliferative and pro-apoptotic effects by arresting the cell cycle within cancer cells, promoting mitochondria-mediated apoptosis, and modulating oxidative stress. In studies related to breast cancer utilizing cell lines such as MCF-7 and MDA-MB-231, the plant extracts have demonstrated the ability to reduce cell viability, inhibit tumor growth, and interfere with signaling pathways implicated in cancer progression, such as NF-κB, PI3K, or Akt, and caspase-dependent apoptotic pathways. The antioxidant properties of its flavonoids and lignans play a significant role in neutralizing reactive oxygen species, thereby mitigating DNA damage and reducing carcinogenic potential [168-170].

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Taxus brevifolia, commonly known as the Pacific Yew, is a coniferous tree of significant medicinal importance. Its bark serves as a natural source of the diterpenoid compound Paclitaxel, known as Taxol. Paclitaxel is one of the most important plant-derived chemotherapy drugs, widely used in the treatment of breast cancer, ovarian cancer, lung cancer, and other solid tumors. Paclitaxel functions by stabilizing microtubules and inhibiting their depolymerization; in doing so, it disrupts the function of the normal mitotic spindle, arrests cells in the G2 or M phase of the cell cycle, and ultimately induces apoptosis in rapidly dividing cancer cells. In the treatment of breast cancer, paclitaxel has demonstrated remarkable efficacy, particularly when used in combination with other chemotherapy drugs, inhibiting the proliferation of tumor cells, reducing metastatic spread, and improving patient survival rates. Its mechanism of action involves binding to β-tubulin subunits, promoting the abnormal assembly of microtubules, and blocking critical cellular processes essential for mitosis [171-173].

Withania somnifera, commonly known as Ashwagandha, is a significant medicinal plant in Ayurveda. Its roots and leaves contain bioactive withanolides, specifically Withaferin A, which have been extensively studied for their anti-cancer properties, particularly their efficacy against breast cancer. Withaferin A is a steroidal lactone that exhibits potent anti-proliferative effects, inhibiting cell growth, inducing cell death, and having anti-inflammatory and anti-angiogenic properties, inhibiting blood vessel formation. In breast cancer cell lines such as MCF-7 and MDA-MB-231, Withaferin A has been found effective in inhibiting the proliferation of tumor cells. It induces apoptosis by activating caspase-dependent pathways, disrupts cytoskeletal proteins such as Vimentin, and modulates signaling pathways, including NF-κB, PI3K/Akt, STAT3, and ROS-mediated stress responses. It also arrests the cell cycle, suppresses the Epithelial-Mesenchymal Transition (EMT), and inhibits metastasis by downregulating Matrix Metalloproteinases (MMPs) and Vascular Endothelial Growth Factor (VEGF). The studies conducted on animals have further substantiated its potential to reduce tumor size and impede the progression of breast cancer, while also demonstrating that its toxicity toward normal cells is relatively low [174-176].

Ginger, commonly known as *Zingiber officinale*, is a widely utilized medicinal and dietary plant. Its rhizome contains biologically active phenolic compounds such as Gingerols, specifically 6-gingerol and shogaols, which are formed during drying or thermal processing and are responsible for its potent anti-inflammatory and anti-cancer properties, including activity against breast cancer.

The studies have demonstrated that gingerols and shogaols inhibit the proliferation of cancer cells, induce apoptosis, suppress angiogenesis, and reduce metastasis by modulating various molecular pathways, such as NF-κB, PI3K/Akt, MAPK, and caspase-dependent signaling. In breast cancer cell lines such as MCF-7 and MDA-MB-231, ginger extracts and isolated compounds have exhibited cytotoxic effects by inducing cell cycle arrest, enhancing oxidative stress generated by reactive oxygen species within tumor cells, and regulating pro- and anti-apoptotic proteins such as Bax and Bcl-2. Furthermore, ginger demonstrates robust anti-inflammatory activity by inhibiting cyclooxygenase-2 (COX-2) and pro-inflammatory cytokines, which play a pivotal role in tumor growth and progression. Pre-clinical animal studies support its potential to attenuate tumor growth and enhance the efficacy of conventional chemotherapeutic drugs, while simultaneously mitigating toxicity [177-179].

Silybum marianum, commonly known as Milk Thistle, is a medicinal plant whose seeds contain a flavonolignan complex called Silymarin. It is primarily composed of silybin (silybinin), silydianin, and silychristin. Extensive research has been conducted on this plant regarding its hepatoprotective (liver-protecting), antioxidant, and emerging anti-cancer properties, particularly concerning its potential utility in the treatment of breast cancer. Silymarin exerts a protective effect against chemotherapy-induced toxicity specifically by reducing oxidative stress, lipid peroxidation, and inflammation in the liver and other tissues, thereby improving tolerance to anti-cancer treatments. In research conducted on breast cancer, silybinin has demonstrated anti-proliferative, growth-inhibiting, and pro-apoptotic effects in cell lines such as MCF-7 and MDA-MB-231 by modulating various signaling pathways. These effects include inhibiting the activation of PI3K or Akt, STAT3, and NF-κB, as well as upregulating the levels of tumor suppressor proteins such as p53 and Bax. It also inhibits cancer metastasis and angiogenesis by reducing the levels of Matrix Metalloproteinases (MMPs) and Vascular Endothelial Growth Factor (VEGF), and arrests the cell cycle at the G1 or S phase. In addition to its direct anti-cancer effects, silymarin also helps protect normal cells from chemotherapy-induced damage, thereby emerging as a promising adjuvant therapy in cancer treatment [180-182].

VI. Conclusion

Breast cancer remains a major health issue, but advances in diagnosis and treatment have significantly improved survival rates.

While conventional treatments such as surgery, chemotherapy, and radiation are the standard, there is a growing body of evidence supporting the potential role of medicinal plants in supporting cancer care. These plants offer complementary benefits, from reducing side effects to enhancing the effectiveness of conventional treatments. However, the use of medicinal plants should always be discussed with healthcare providers to ensure safety and efficacy in combination with standard cancer therapies.

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