“Moringa oleifera: A Natural Ally in Breast Cancer Management!’’

Sanskruti Santosh Sabale[a] , Ajit B. Tuwar[b], Dr. Megha T. Salve[c]
[a]Shivajirao pawar college of pharmacy, pachegaon 413721.

[b]Principal Department of pharmaceutical chemistry, Shivajirao pawar college of pharmacy pachegaon 413721.

[c]Assistant professor Department of pharmaceutics Shivajirao pawar college of pharmacy pachegaon 413721.

Corresponding author E-mail: sanskrutisabale@gmail.com

1.Abstract
Breast cancer is the most frequent and fatal malignancies globally demanding the development of novel treatment and preventative measures. Moringa oleifera is well recognized as the "miracle tree" or “ drumstick tree’’ or “superfood” the plant is high in bioactive elements such flavonoids, vitamins, and polyphenols, has garnered popularity for its powerful anticancer capabilities. Breast cancer remains amongst most prevalent cancers affecting women globally. Despite of having advances in treatment, there is growing interest in alternative therapies using natural products. Moringa oleifera is known for its rich phytochemical content and diverse medicinal properties. This review explores the potential anti-cancer activity of MO leaves, focusing its depth in breast cancer treatment. Moringa leaves are a richest source of biologically active compounds such as flavonoids, phenolics, and glucosinolates, which have shown significant anti-proliferative as well as pro-apoptotic properties in numerous cancer of cell outlines, involving breast cancer. These compounds may act through multiple mechanisms, of inhibiting cancer cell growth, promote apoptosis, and modulating oxidative stress and inflammation. Furthermore, studies suggest that Moringa oleifera may increase the effectiveness of traditional cancer therapies while minimizing their side effects. Although preclinical findings are promising, more in-depth clinical trials are vital to fully comprehend the therapeutic capability of Moringa oleifera in breast cancer treatment. The review goals to deliver a comprehensive summary of the recent research on Moringa oleifera leaves and their potential role in treating breast cancer, highlighting its possible integration into complementary cancer therapies.

Keywords: Moringa oleifera, breast cancer, anti-cancer activity, natural compounds, apoptosis, oxidative stress, complementary therapy

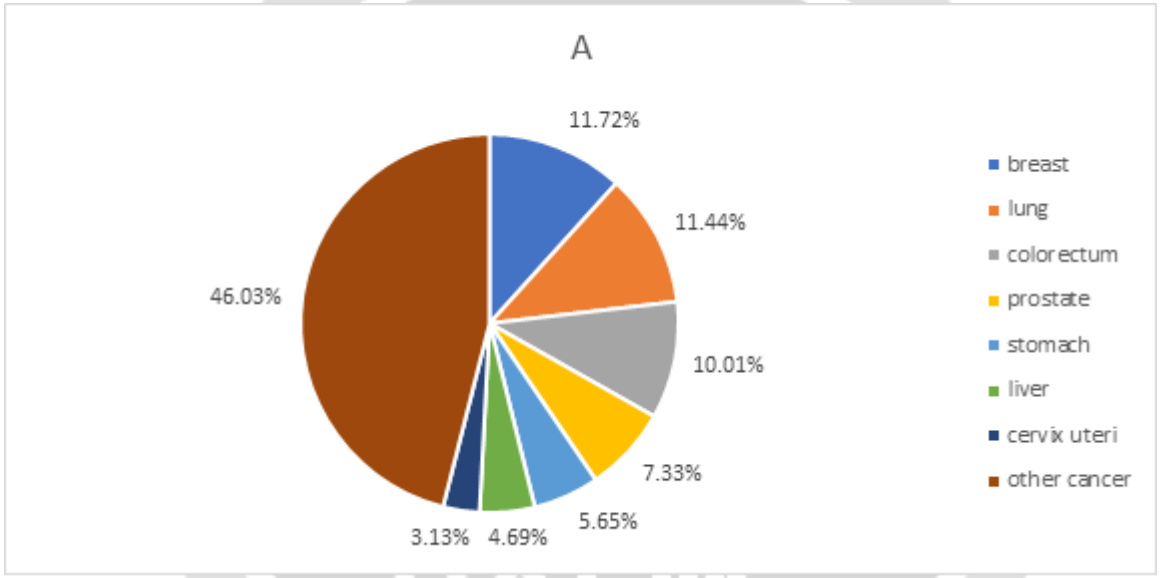
2.Introduction

Moringa oleifera L, often recognized as Moringa, drumstick tree, or ben oil tree, is a multifunctional strong-growing and drought-resistant tree from the Moringeceae family. [1,2] Most notably, the WHO has recognized miracle trees as an alternate source of dietary supplements to combat hunger .[3,4] its antiproliferative outcome of M. oleifera crude aq. leaf extract on breast adenocarcinoma (MDA-MB-231) cancer cells.[5]
In this case we focused upon the effect of moringa oleifera extract from leaves to observe its efficacy as an anticancer agent on breast cancer. Moringa oleifera leaf extracts (MLE) can cure over 300 ailments, such as Skin issues, diabetes, high blood pressure, cancer, cognitive dysfunction, arthritis, and obesity.[6-8]Moringa leaf powder addition to breastfeeding women' diet increase milk Grade and Nutritional Content, promoting healthy child growth [9]. Cancerous tissue/cells are referred to as malignant, and non-cancerous tissue is called benign. The Malignant tumors can spread to neighboring tissues and distant places, a process known as metastasis. Solid tumors can originate from several types of cancers [10] Breast cancer has been biggest reason of death for women internationally. bookkeeping for the majority of malignant tumors . Breast cancer formation and progression involve complex anatomical and molecular pathways. Recent work has addressed the current understanding of the typical A macro and the microscopic anatomy of the human mammary gland. Furthermore, the human mammary gland grows and differentiates from embryonic to postmenopausal age [11]. Sir Astley Paston Cooper (1768-1841) 1840 saw the description of mammalian breast dissections, which are currently used to research breast anatomy.[11]
This work focuses on Moringa oleifera, is the medicinal tree that shows the antioxidant properties and promote cell death in many cell line causing cancer, also including HepG2 liver cancer cells. [12] The MO tree is modest, measuring 5 to 10 meters in height. It is widely farmed globally due to its several benefits. [13] Every component of MO is utilized for the nutritional and therapeutic purposes. It is rich in protein, vitamins, lipids,

micro-macro minerals ,also the fatty acid elements, the and phenolics, and has been linked to anti-cancer and anti-inflammatory qualities. Missouri tree is demonstrated to reduce oxidative and function as an antimicrobial content , and protect the liver .[13]

3. Breast Cancer Epidemiology.

Breast cancer is one of the most frequently caused cancer among women it is second biggest cause of death worldwide.[14]At the year 2020, there were an expected 10 million cancer-related deaths globally. [15] Breast cancer diagnosed in female made up 11.7% of anticipated 19.3 million new cancer cases worldwide (Figure 2). [15]Without treatment, almost 1.3 million people are expected to die from the condition .[15]In 2020, 108,168 cancer patients and 56,802 cancer-related fatalities were recorded in Southern Africa, which populates 59 million. [16]Breast cancer accounted for nearly one-third of all cancer cases (27.1%) .[16]Breast cancer is prevalent globally, however mortality rates, survival rates, and prevalence vary based on risk factors. [17] Since 2008, the number of cases of BCA has risen from 1.67 million in 2012, 1.38 million to 2.1 million in 2018, & 2.3 million in 2020, representing a 130% increase.1-5 According to the World Health Organization's 2016 Worldwide Health Forecasts, cancer is the biggest cause of disabled-adjusted life years (DALYs) among women, with Bca accounting for 18% (19.6 million DALYs).6 BCA is the top cause of female cancer-related mortality globally, leading to 458,000 fatalities in 2008, 522,000 in 2012, 626,679 in 2018, and 685,000 in 2020. This is a rise of fifty percent from 2008. [18]



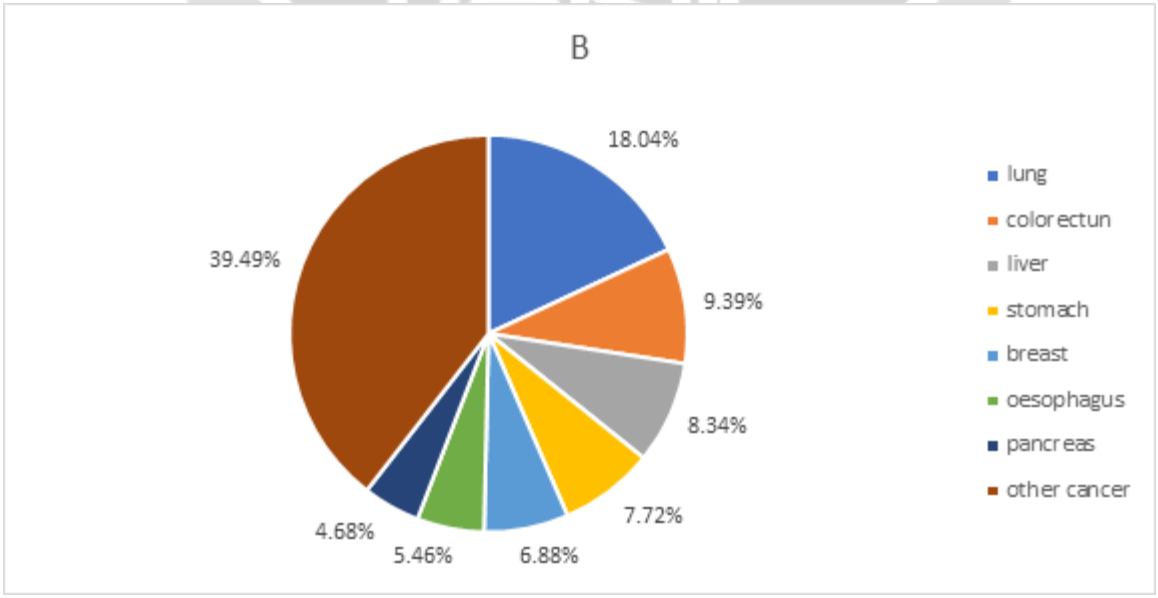


Figure 1. Global projections of the Rates of occurrence and death of cancer, involving breast cancer: (A) predictions of new cancer cases worldwide in 2020, including breast cancer. (B)Estimations of cancer death rates worldwide. [19]

4.Pathophysiology of breast cancer

Breast cancer develops because of DNA damage and gene alterations it is caused via exposure to receptors for oestrogen, receptors for progesterone, and development of the human epidermis receptor 2. [20,21] The immune system attacks cells with aberrant DNA in remission of individuals. Failed to combat fast aberrant DNA development can lead to tumor growth. Breast cancer recurrence can be predicted using tumor markers .[22]Metastatic breast cancer can arise within three years in people with no tumor markers or 10 years after the primary diagnosis and therapy inPatients who are positive for estrogen receptor .[22] Breast cancerous cells can affect either the ductal or lobular epithelium. [23]Most breast cancers start in the ductal epithelium, although they can also develop in lobular glands . At some circumstances, DNA abnormalities or pre-cancer cells like BRCA1, BRCA2 can become heir to. Having a ancestral tree of breast cancer enlarge the likelihood of development the disease. Women should regularly check for breast cancer, especially when they have a bloodline past of the cancer [23]

5.Diagnosis of breast cancer

Breast cancer is identified by screening and the diagnostic exams based on symptoms. [24] Mammography has seen progress in breast cancer detection also cut mortality by 19%. The suggested age for women is 45. [24]female with BRCA1 and BRCA2 mutational genes are more prone to development of breast cancer .[25]Person with a bloodline history of cancer should have a yearly mammography starting at age 25 and no later than age 40. The American Cancer Society endorse using magnetic resonance imaging (MRI) with mammography to categorize and measure breast cancer, including tumor size .[24]

6.The Potentiality of Herbal Drugs in Chemotherapeutic Regimens

Alternative therapy options have gained popularity in recent years. [26]Herbal medications have been used to treat and prevent illnesses, including type 2 diabetes, female breast cancer, and HIV .[27]Numerous studies have been conducted on traditional medicines (Curr. Issues Mol. Biol. 2023, 45 6892). Antiproliferative condition have been seen in many cancer cells, including Pinocembrin, a natural medication which promotes death of the cells and necrosis in breast cancer cells [28]
Flavonoids, a kind of plant-based medicine, have been intensively studied for their potential to protect against chemotherapy-related toxicity .[29]Flavonoids are polyphenolic chemicals renowned for their anti-inflammatory, antioxidant ,cardio-protective,anticarcinogenic.[29]Plants are increasingly being used to treat ailments. Natural products have been used to treat chronic and acute disorders. [30]Plant-based therapies offer anti-cancer capabilities, according to research. [30]

7.Moringa Oleifera

Moringa oleifera (MO), which is used in traditional medicine in South Africa. [31] Moringa oleifera (MO), belonging to the Moringaceae family, is an indigenous tree in India.
and may be found across South Africa .[32]It is usually referred to as horseradish or the drumstick tree. Moringa oleifera is said to be the "powerhouse" of energetic nutritive value. The leaves include copper, calcium , magnesium, , zinc, potassium & iron. It consists of vitamins A, B, C, D, and E .MO has long been used in the treatment of viral and bacterial infections, magnesium, potassium, zinc, and iron. It consists of vitamins A, vitamin B, vitamin C vitamin D, and E .[32-34]MO has long been used in the treatment of bacterial& viral infections, hyperglycemia & inflammation.[35] it's been used historically in several nations, including Nigeria, to treat female reproductive issues and boost male fertility capacity . MO seeds have been shown to filter water in Africa, including Ethiopia [.36] MO includes niazimicin, a thiocarbamate that inhibits cancer cell growth. It includes benzyl isothiocyanate, which boosts intracellular ROS and cell death , highlighting MO's anti-cancer ability .[37]

Figure 2 :

Figure:-A) Flowers of the Moringa oleifera tree B)leaves of Moringa oleifera tree

MO has also been used historically including several nations, including Nigeria, to treat female reproductive issues and boost male fertility capacity. MO seeds have been shown to filter water in Africa, including Ethiopia .[38-39] MO includes, a thiocarbamate , niazimicin that inhibits cancerous cell growth. [40-41]also includes benzyl isothiocyanate, which boosts intracellular ROS and cell death, highlighting MO's anti-cancer latent .MO's leaves, pods, and seeds contain a variety of phytochemicals, including flavonoids, sterols and anti-cancer compounds such isothiocyanates, glucosinolates, and glycosides .[42]MO also includes zeatin, anti-aging ingredient. Zeatin possesses anti-cancer effects also is an effective antioxidant agent . It contains bioactive components with anti-cancer capabilities, including saponins and tannins, as well as alkaloids that may stimulate the heart . This might potentially avoid the cardiac issues caused by Dox .[42]

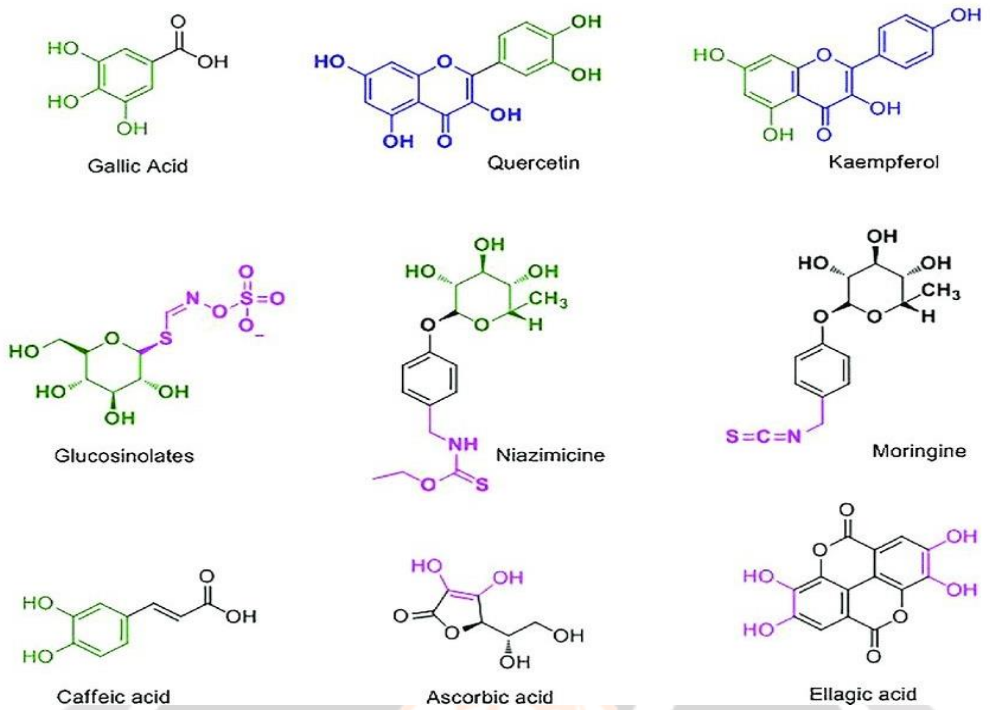


Figure 3.chemical compositions of MO's bioactive substances. MO is a good chemotherapeutic agent because of a number of different chemicals. This includes kaemferol, qurcetin, and niazimicin . additionally the different hues show compunds that had a hyfroxyfunctional group that was soluble in water, which was what reduced the gold ions and stabilized the gold nanoparticles (AuNPs).[38-43]

Studies indicate that MO's strong antioxidants and bioactive substances can protect cardiac damage caused by chemotherapeutic drugs like Dox .[44] Gopalakrishnan et al. (2016) suggest that MO can effectively cure childhood malnutrition. The "miracle tree" is known for its quick growth, versatility, and drought tolerance, as well as its nutritional and therapeutic benefits .[32]More study is needed to understand how MO and Dox herb-drug interactions affect the cytochrome P450 enzymes such as CYP3A4, CYP2D6,CYP1A2 of liver cells. [45-47] Asare and coworkers found supplementing with MO leaf extract would be harmful at levels over 3000 mg/kg body. Asare and coworkers found that supplementing with MO leaf extract can be harmful at levels over 3000 mg/kg body.[48]

Table 1. MO's phytochemical composition. Compared to other compunds, MO leaves contain higher flavonoids and saponins[49]

constituents	Aqueous Extract
Amino acids and proteins	++
Phenols	+
Fixed oils and fats	++
steroids	++
Flavonoids	+++
lignin	ND
Carbohydrates	++
Tannis	++
saponins	+++
Gums and mucilage	++
Fixed oils and fats	++
Alkaloids	++

Note: + = molecule with a low concentration complex
++ = modest profusion complex
+++ = reasonable profusion complex
ND = Not detected.

8.Anti-Cancer Properties of Moringa oleifera

MO has promise as a supplementary therapy for cancer. The bark & leaves are powerful anticancer agents. It demonstrated antiproliferative properties in MDA-MB-231 & HCT-8 cancer cells. Though, the extracts of seeds proved ineffective. Apoptosis occurs at G2/M phase cell cycle arrest. The bioactive substances hexadeconoic acid ethyl ester,D-allose, isopropyl isothiocyanate & eugenol has been also seen to have an anticancer impact. This is significant since the found bioactive molecules contain sweeteners, and long chain hydrocarbons. This highlights MO's ability for developing innovative drugs.[50]MO contains many phytochemicals . Ingredients including flavonoids, quercetin ,minerals, vitamins, kaempferol, phenols . In addition, it includes carotenoids, alkaloids, phenolic acid glucose and isothiocyanates . The leaves have larger amounts of bioactive chemicals, which enhance their medicinal effects.[51]

MO leaves contain flavonoids with a common benzo-γ-pyrone ring . Plants manufacture flavonoids as a defense against microbial illnesses. Consuming flavonoids like ,kaempferol ,quercetin, and myrecytin help reduce oxidative stress and prevent cancer and cardiovascular disease. Kaempferol, an aglycone flavonoid, has anticancer properties against the tumor, breast cancer, tumors of the liver, colorectal tumors, acute leukemia caused by myeloid cells, pancreatic cancer, renal cancer, and prostate cell carcinoma.48 Kaempferol exhibits drug-like characteristics without breaking Lipinski ROF, with a binding energy of -3.666 kcal/mol.[52]

Phenolic acids are composed of hydroxycinnamic and hydroxybenzoic acids.

M. oleifera has been shown to reduce cancer progression by targeting chemoprevention, preventing carcinogen activation, promoting detoxification, reducing inflammation, limiting tumor cell proliferation, and inducing apoptosis. The study found that the methanol-based extract of M. oleifera leaves has cytotoxic action in contradiction of human breast cell lines MDA-MB-231 & T-47D, making it a potential cancer-preventing agent.[53]

Table 2.Moringa Oleifera's anticancer effects.

Experimental model	**Mo dose**	**Experimental outcome**	**Proposed mechanism**	**Referrences**
Human B-lymphocyte plasmacytoma (U266B1 cell line)	IC50 for menthol extract:0.32 ug/ml	A rise in cytotoxic activity	Cell proliferation inhibition	[54]
Colorectal cancer (CRC) cell lines T84, HCT-15, SW480 and HT-29	Aqueous leaf extract 0.75 mg/ml	Reduction of P65 expression	Inhibition of growth of cells	[55]
Lung cancer (A549 cell line)	Soluble cold distilled water extract 200 ug/ml	Reduced expression of AKT,ERK,NFKB And cyclone DI	Activated caspases to cause apoptosis	[56]
Lung cancer (A549 cell line)	IC 50 for water-soluble extract:0.001 ug/ml	Decreased GSH levels and DNA damage Caused by drop in PARP-1 And Nrf2 levels	Caspase activation causes apoptosis	[57]

Hepatocarcinoma (HepG2) and breast adenocarcinoma (MCF-7)	Dichloromethane extract 100 ug/ml	Showed anti-cancer action by increasing DND damage, decrease cell viability and mitochondrial membrane potential	Caused apoptosis through the upregulation of Bax proteins	[58]
Breast adenocarcinoma (MCF-7) and epithelial breast cancer cell line (MDA-MB-231)	Crude methanolic leaf extract 50 and 25 ug/ml	A rise in apoptosis accompanied by a decline in cell viability	Apoptosis brought triggered by DNA breakage	[59]
Hep2 human epidermoid	Menthol extract 200 ug/ml	DNA fragmentation	Induction increased ROS to cause apoptosis	[60]
Cervical cancer (HeLa cell line)	Menthol leaf extracts IC50: 70 ug/ml	A rise in apoptosis accompanied by a reduction in cell viability	Apoptosis brought triggered by DND breakage	[61]
Pancreatic cancer (Panc-1 cell line)	Aqueous leaf extract 0.75 mg/mL	Reducution in the p65 expression	Inhibition of cell proliferation	62]

9.Risk factors of breast cancer

Age

Aside from aging, sex is a vital hazardous factor of breast cancer. The possibility of breast cancer rises with age. In 2016, 71.2% and 99.93% of breast cancer-related fatalities in America were recorded in women over 40 and 60, respectively .Women aged 40 and up should schedule a mammography screening in advance**.**[63]
Breast tumors in younger women had greater sizes, stages of advancement, positive lymphatic vessels, and worse rate of survival.[64]

Family history

Approximately 25% of breast cancer occurrences are linked to family past.[65] Women who have a family past history of breast cancer are more likely to develop it themselves.
A longitudinal study of 113,000 women in the UK found that having first-degree family with breast cancer increases the probability of contracting the illness by 1.75 times compared to those without any afflicted relatives. Women with more than two relatives who have been diagnosed with breast cancer appearance to 2.5-fold or greater hazard.[65] Alterations in genes like BRCA1 and BRCA2 contribute to hereditary vulnerability to breast cancer.
Individuals with a family past of breast cancer may benefit from increased breast screening by magnetic resonance imaging or tamoxifen chemoprevention [66]

Reproductive factors

Early menarche, late menopause, late age at first pregnancy, and poor parity can all raise the chance of developing breast cancer. Each one-year delay in menopause raises the risk of breast cancer by 3%. Each one-year delay in menarche or extra birth reduces the risk of breast cancer by 5% or 10%, respectively .[67–69]A recent Norwegian cohort research found a hazard ratio (HR) of 1.54 for late (≥35 years) and early (<20 years) age at first birth [70].Reproductive variables are substantially connected with the ER status, with variations in the odds ratios (OR) between ER+ and ER- breast cancer for parity (OR: 0.7 vs. 0.9 for ≥3 births vs. nulliparae) and age at first birth (OR: 1.6 vs. 1.2 for age ≥30 vs.<25 years) [71].

Estrogen

The exogenous & endogeneous estrogens increase the hazard of breast cancer. In premenopausal women, the ovary produces endogenic estrogen. Ovariectomy can lesser the hazard of breast cancer. [72]Exogenous estrogen is mostly derived via oral contraceptives and hormone replacement treatment. The Oral contraceptives has been extensively cast-off since the 1960s, and their preparations have been improved to minimize negative properties. Though, the OR remains more than 1.5 for African American women and Iranian peoples.[73] Oral contraceptives do not enhance the incidence of breast cancer in women who stop using them for over ten years. Hormonal replacement therapy (HRT) administers exogenous estrogen or other hormones to postmenopausal women or menopausal women. Research indicates that using hormone replacement therapy may raise the chance of developing breast cancer. In the UK's Million Women Study, current HRT users had a relative hazard (RR) of 1.66 compared to non-users. Breast cancer survivors who use hormone replacement therapy had a significant recurrence rate, with a 3.6-fold higher risk of developing a new breast tumor. [74]

lifestyle

Extreme alcohol consumption and higher dietary fats consumption have been linked to an increased hazard of breast cancer. the Alcohol drinking can increase the levels of estrogen-related hormones in the blood, activating estrogen receptor paths. The meta-analysis of 53 epidemiological studies found that consuming 35-44 grams of alcohol per day increases the hazard of breast cancer by 32%, with a 7.1% rise in the RR for each additional 10 grams per day .[75] Excess fat, particularly saturated fat, has been linked to death (RR=1.3) and a poor prognosis in breast cancer patients .[76]While the link among breast cancer risk is debated & smoking, mutagens from cigarette smoking has been found in breast liquid from non-lactating women. Women who smoke and drink are more likely to get breast cancer (RR = 1.54). [77]

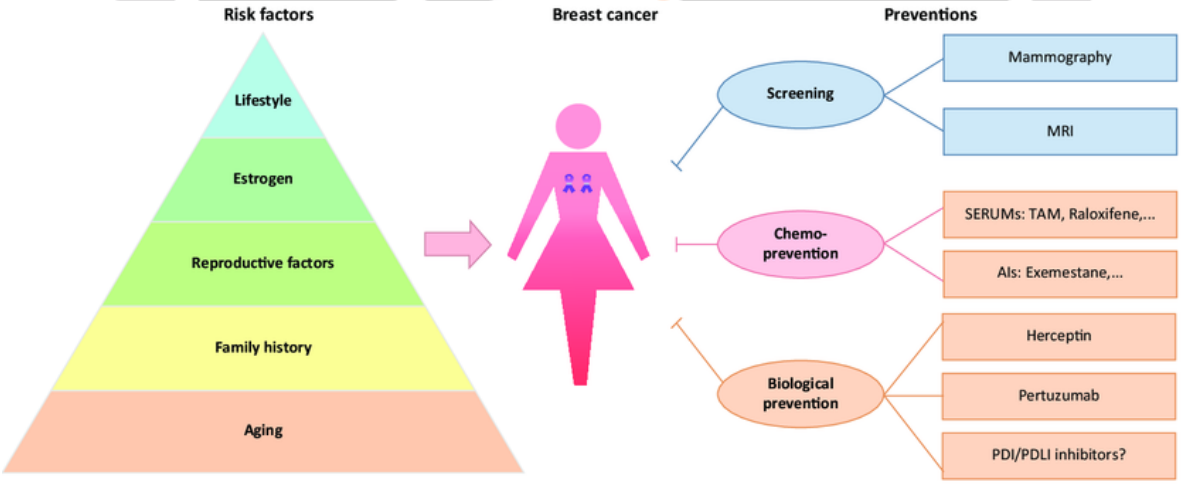


Figure 4:- Schematic depiction illustrating breast cancer risk factors and preventative strategies. The pyramid graphic represents five key risk factors for breast cancer: family reproductive factors .history, age, estrogen &lifestyle. the Breast cancer prevention strategies include transmission (MRI & mammography), chemoprevention (using Ais & SERMs), and pharmacological therapy (using Pertuzumab and Herceptin). PD1/PDL1 inhibitors are immunotherapy medications that may show promise in treating TNBC.

Prevention

Breast cancer research has made significant progress, as seen in Figure 4. Modern preventative strategies, involving as transmission, chemoprevention, and biological anticipation, are more effective than previous ones (see Figure 4). Breast cancer death rates have dropped. Breast cancer is the top reason for cancer mortality amongst females aging 20-59.

Screening

Over 90% of cancer fatalities are caused by metastases rather than primary tumors.[78]If breast cancer is detected as an initial tumor or in an initial phase of metastasis, surgery and chemotherapy may be effective treatments. Prevention of breast cancer relies heavily on detection at an early stage. Mammograms is a reliable screening tool that uses X-rays with a low energy to capture higher-resolution pictures of the breast. The testing technique just takes 20 minutes and does not require slightly contrast-enhancing agents. Meanwhile Professor Forrest's initial advice for breast cancer transmission, approximately 70% women in America aged 50-74 have received mammography every two years .[79] A meta-analysis of 11 random trials originate that screenings with mammography significantly compact breast cancer mortality among women aged 50-70 years (RR=0.81). [80] Though, the decrease in death rate was not substantial for women aged 40-49 years .[81] These findings highlight the relevance screening programs of mammarography. Overdiagnosis from mammography is a significant issue it won't be ignored during breast cancer screening, despite varying reported rates between trials.

MRI

MRI is another popular screening method for breast cancer. In higher-risk female, is more sensitive as compared to mammography for identifying aggressive ductal carcinoma. [82]MRI is more sensitive than mammography and can identify concealed primary breast cancer, axillary nodal metastases, remaining tumors afterwards of neoadjuvant treatment, and extra tiny tumors .[83] Progressive MRI scanners are also used to measure tissue as tiny as 0.5 mm3. MRI has not been shown to improve patient outcomes, including detection of ipsilateral breast tumor reappearance or contralateral breast cancer.MRI has lesser specificity than mammography, by detection rates varying from 37% to 100% .[84]MRI screening indicates that females with a family past of breast cancer have a 20-25% or greater lifetime chance of developing the disease .[85]To achieve balance, we must consider both the positive and negative aspects.MRI may be a beneficial option in higher-risk populations with normal mammography outcomes due to its great sensitivity.

Chemoprevention

Chemotherapy, according to Sporn, is "the use of pharmacologic or natural agents that inhibit the development of invasive breast cancer either by blocking the DNA damage that launches carcinogenesis or by arresting or reversing the progression of premalignant cells in which such damage has already occurred.[86] Chemotherapy focuses on ER-positive breast tumors, which account for almost 70% of all cases.

Anti-estrogen medications falls under two categories: aromatase inhibitors and selective estrogen receptor modulators (SERMs) . SERMs can operate as antagonists or the agonists of estrogen receptors.TAM has the greatest clinical data in SERMs, regardless of its size, scope, or duration of follow-up studies. TAM can cure entirely phases of breast cancer .[87]

Several large-scale trials, including the Breast Cancer Prevention Trial (NSABP-1), the Italian Prevention Trial, the Royal Marsden Prevention Trial, and the International Breast Cancer Intervention Study (IBIS-I), are founded that TAM can lower the hazard of both non-invasive breast cancer and invasive cancer . Despite discrepancies in data collecting and research design, all trials found that TAM therapy reduced ER-positive breast cancer by more than 30% after 5 years. However, no substantial decrease was found in ER-negative tumors.[88]

However, there are certain adverse effects of TAM treatment. TAM treatment raises the risk of cancer of the endometrium, stroke, deep-vein thrombosis, pulmonary embolism particularly in women over 50 .[89]

TAM should be taken in moderation, taking into account its toxicity and advantages.Raloxifene, a the subsequent generations SERM having fewer adverse effects than TAM, is licensed for treating postmenopausal females having aggressive breast cancer, bone loss, & cardiovascular disease. [90]

Biological prevention.

Biological prophylaxis, such as monoclonal antibody therapy, can enhancing the quality of life for breast cancer patients. Those monoclonal antibodies that are produced primarily target HER2. Approximately 20-30% of breast cancer patients show gene amplification or HER2 protein overexpression .[91]

It is yet unknown how trastuzumab works as an anti-tumor agent. By enlisting ubiquitin to break down HER2, stimulating the immune system through antibody-dependent cell-mediated cytotoxicity (ADCC), or blocking the PI3K/Akt pathways and MAPK trastuzumab may decrease the development and reproduction of cancer cells. Trastuzumab was firstly utilized in treatment of metastatic breast cancer (MBC) and shown efficacy as a single drug, with an ORR of 26%. Trastuzumab synergizes within another anti-tumor medicines, including, carboplatin, nimotuzumab, 4-hydroxycyclophosphamide and vinorelbine, docetaxel according to in vitro tests. [93]

The TRAIN & HERA studies found that combining chemotherapy by adjunct trastuzumab for one year improved disease-free survival in patients with HER2+ breast cancer (HR=0.76) .[94]Marty's randomized phase II study found that trastuzumab with docetaxel remained more effective as compared to docetaxel alone in treating HER2-positive MBC, combine to ORR of 50% vs. 32%. [95] the Trastuzumab treatment has been linked to adverse effects include congestive heart failure and decreased left ventricular ejection fraction (LVEF). [96]
Pertuzumab coupled with trastuzumab and docetaxel is authorized to treat HER2-positive breast cancer. HER+ cancers had a considerably higher pathological wide-ranging response (pCR) rate and invasive-disease-free existence rate compared to HER- tumors (57.8% vs 22.0%) .[97]Pertuzumab treatment was associated with severe side effects such as diarrhea and febrile neutropenia.

future prospectives

This review indicate that Moringa oleifera may have considerable medical utility due to its anticancer and cytotoxic effects also might help prevent and cure cancer. Additional clinical testing with human participants are needed to establish M. oleifera's good impact on cancer therapy. It is also crucial to analyze its interactions with medications used to treat these disorders.[98]
Cancer is the biggest cause of death worldwide, and current treatments have a number of negative effects. The cost of medicines is continuously increasing, limiting admission to crucial life-saving operations. Alternative treatments are critical in making therapy more accessible for many. Usual medicine has been an important foundation for these alternative medicines. MO has demonstrated possible by way of anticancer agent. The medicine should have a maximal therapeutic benefit while minimizing harmfulness and negative properties. There are various targets for the creation of an anticancer drug. Inhibition of apoptosis proteins (IAPs) are frequently increased in cancer. [98].
The introduction of novel remedies and strong medicinal drugs in native medical systems has confounded determining the risk of breast cancer. Breast cancer treatment options include surgical oncology, , radiation therapy, chemotherapy hormone therapy, & targeted therapy. However, these therapies may cause significant side effects. Validating putative anti-cancer medications derived from plants can lead to the creation of effective treatment options while minimizing unwanted effects. More study is needed to assess the potential injurious properties of M. oleifera abstracts and goods on humans and animals, as there are currently no recognized risks at oral dosages. [99]

8.Conclusion

Therapeutic plants, particularly natural compounds, have an important role in drug discovery and development. Moringa oleifera's secondary chemicals have a variety of biological and pharmacological effects. Data was acquired and evaluated from academic articles. M. oliefera is now utilized to treat cancer and has demonstrated effectiveness in laboratory tests and limited study on living animals. The study discovered that the species mostly suppresses the multiplication of cancer cells, with little effect on normal cells.
Mo having improved physical properties, lower cytotoxicity, and antiproliferative potential on breast cancer cell lines. The substantial antiproliferation effect might be ascribed to the large concentration of polyphenol chemicals contained by the current phytosomes, which may accelerate apoptosis.This suggests that moringa oleifera might be utilized in preventive and treatment of cancer.The scientific study given in this review suggests that Moringa oleifera may be highly appreciated in medicine due to its anticancer and cytotoxic capabilities. This shows that M. oleifera might be utilized to prevent and cure different cancers.

8.Acknowledgement

The authors would like to sincere gratitude to Dr.Salve mam mentor Ajit Tuwar sir for guidance and I am also greatful to Sangale sir for invaluable support and significant advices

References

1. Dilipkumar pal, Sujoy Thakur, Takeshwar and Milan Hait , Exploring the anticancer potential and phytochemistry of moringa oleifera: A multi-targeted medicinal herb from nature
2. M. Jattan, N. Kumari, R. Kumar, A. Kumar, B. Rani, D. S. Phogat, S. Kumar, P. Kumar, Moringa (Moringa oleifera L.): an underutilized and traditionally valued tree holding remarkable potential, Journal of Horticultural Sciences, 2021, 16, 1-13, doi: 10.24154/jhs.v16i1.1073.

3. A. Idris Maizuwo, Phytochemical constituents, biological activities, therapeutic potentials and nutritional values of Moringa oleifera (zogale): a review, Journal of Drug Design and Medicinal Chemistry, 2017, 3, 60, doi: 10.11648/j.jddmc.20170304.12.
4. Yongqiang, Wang, Subcritical ethanol extraction of flavonoids from Moringa oleifera leaf and evaluation of antioxidant activity, Food Chemistry, 2017, 218, 152-158, doi: 10.1016/j.foodchem.2016.09.058.
5. E. A. Elsayed, M. A. Sharaf-Eldin, M. Wadaan, In vitro evaluation of cytotoxic activities of essential oil from Moringa oleifera seeds on HeLa, HepG2, MCF-7, CACO-2 and L929 cell lines, Asian Pacific Journal of Cancer Prevention, 2015, 16, 4671-4675, doi: 10.7314/apjcp.2015.16.11.4671.
6. Sadek, K. Chemotherapeutic efficacy of an ethanolic M oringa oleifera leaf extract against chromium-induced testicular toxicity in rats. Andrologia 2014, 46, 1047–1054
7. Stohs, S.J.; Hartman, M.J. Review of the safety and efficacy of Moringa oleifera. Phytother. Res. 2015, 29, 796–804.
8. Metwally, F.M.; Rashad, H.M.; Ahmed, H.H.; Mahmoud, A.A.; Raouf, E.R.A.; Abdalla, A.M. Molecular mechanisms of the anti-obesity potential effect of Moringa oleifera in the experimental model. Asian Pac. J. Trop. Biomed. 2017, 7, 214–221
9. Bhatnagar, A.; Krishna, A.G. Natural antioxidants of the Jaffna variety of Moringa oleifera seed oil of Indian origin as compared to other vegetable oils. Grasas Y Aceites 2013, 64, 537–545.
10. Ohshika, S.; Saruga, T.; Ogawa, T.; Ono, H.; Ishibashi, Y. Distinction between benign and malignant soft tissue tumors based on an ultrasonographic evaluation of vascularity and elasticity. Oncol. Lett. 2021, 21, 28
11. McGowan, J.V.; Chung, R.; Maulik, A.; Piotrowska, I.; Walker, J.M.; Yellon, D.M. Anthracycline Chemotherapy and Cardiotoxicity. Cardiovasc. Drugs Ther. 2017, 31, 63–75.
12. Suphachai, C. Antioxidant and anticancer activities of Moringa oleifera leaves. J. Med. Plants Res. 2014, 8, 318–325
13. Farooq, F.B.; Rai, M.; Tiwari, A.; Khan, A.A.; Farooq, S. Medicinal properties of Moringa oleifera: An overview of promising healer. J. Med. Plants Res. 2012, 6, 4368–4374
14. Bray, F.; Ferlay, J.; Soerjomataram, I.; Siegel, R.L.; Torre, L.A.; Jemal, A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J. Clin. 2018, 68, 394–424
15. Sung, H.; Ferlay, J.; Siegel, R.L.; Laversanne, M.; Soerjomataram, I.; Jemal, A.; Bray, F. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J. Clin. 2021, 71, 209–249.
16. Globocan. International Agency for Research on Cancer: South Africa fact sheet. Glob. Cancer Obs. 2020, 491, 1–2
17. Momenimovahed, Z.; Salehiniya, H. Epidemiological characteristics of and risk factors for breast cancer in the world. Breast Cancer 2019, 11, 151–1
18. Lakkis, Najla A., et al. "Epidemiology of Breast, Corpus Uteri, and Ovarian Cancers in Lebanon With Emphasis on Breast Cancer Incidence Trends and Risk Factors Compared to Regional and Global Rates." *Cancer Control* 31 (2024): 10732748241236266.
19. Xi, Y.; Xu, P. Global colorectal cancer burden in 2020 and projections to 2040. Transl. Oncol. 2021, 14, 101174
20. Alkabban, F.M.; Ferguson, T. Breast Cancer. In Treasure Island (FL); Broadview Press: Peterborough, UK, 2022.
21. Chalasani, P.; Farr, K.; Wu, V.; Jenkins, I.; Liu, A.; Parker, S.; Gadi, V.K.; Specht, J.; Linden, H. Single arm, phase two study of low-dose metronomic eribulin in metastatic breast cancer. Breast Cancer Res. Treat. 2021, 188, 91–99.
22. Choi, L. Breast Cancer-Gynecology and Obstetrics-MSD Manual Professional Edition.
23. Loomans-Kropp, H.; Umar, A. Cancer prevention and screening: The next step in the era of precision medicine. NPJ Precis Oncol. 2019, 1, 3.
24. McDonald, E.S.; Clark, A.S.; Tchou, J.; Zhang, P.; Freedman, G.M. Clinical Diagnosis and Management of Breast Cancer. J. Nucl. Med. 2016, 57 (Suppl. 1), 9S–16S.
25. Casaubon, J.T.; Kashyap, S.; Regan, J.P. BRCA 1 and 2. Stat Pearls.
26. HemaIswarya, S.; Doble, M. Potential synergism of natural products in the treatment of cancer. Phytother. Res. 2006, 20, 239–249.
27. Kassler, W.J.; Blanc, P.; Greenblatt, R. The use of medicinal herbs by human immunodeficiency virus-infected patients. Arch. Intern. Med. 1991, 151, 2281–2288
28. Sangweni, N.F.; Moremane, M.; Riedel, S.; van Vuuren, D.; Huisamen, B.; Mabasa, L.; Barry, R.; Johnson, R. The Prophylactic Effect of Pinocembrin Against Doxorubicin-Induced Cardiotoxicity in an In Vitro H9c2 Cell Model. Front Pharmacol. 2020, 11, 1172

29. Panche, A.N.; Diwan, A.D.; Chandra, S.R. Flavonoids: An Overview. J. Nutr. Sci. 2016, 5, e47.
30. Jung, I.L. Soluble extract from Moringa oleifera leaves with a new anticancer activity. PLoS ONE 2014, 9, e95492.
31. Mahmood, K.T.; Mugal, T.; Haq, I.U. Moringa oleifera: A natural gift-a review. J. Pharm. Sci. Res. 2010, 2, 775–781
32. Gopalakrishnan, L.; Doriya, K.; Kumar, D.S. Moringa oleifera: A review on nutritive importance and its medicinal application. Food Sci. Hum. Wellness 2016, 5, 49–56
33. Amaglo, N.K.; Bennett, R.N.; Curto, R.B.L.; Rosa, E.A.; Turco, V.L.; Giuffrida, A.; Curto, A.L.; Crea, F.; Timpo, G.M. Profiling selected phytochemicals and nutrients in different tissues of the multipurpose tree Moringa oleifera L., grown in Ghana. Food Chem. 2010, 122, 1047–1054.
34. Karim, N.U.; Siddiq, U.S.A.A.; Razak, M.R.M.; Zainol, M.K.M.; Abdullah, M.I. Effects of moringa leaves (Moringa oleifera) extraction on quality changes and melanosis of giant freshwater prawn (Macrobrachium rosenbergii) during chilled storage. Ital. J. Food Saf. 2018, 7, 6846.
35. Zahirah, N.; Rani, A.; Husain, K.; Kumolosasi, E. Moringa Genus: A Review of Phytochemistry and Pharmacology. Front. Pharmacol. 2018, 9, 108.
36. Delelegn, A.; Sahile, S.; Husen, A. Water purification and antibacterial efficacy of Moringa oleifera Lam. Agric. Food Secur. 2018, 7, 25.
37. Miyoshi, N.; Takabayashi, S.; Osawa, T.; Nakamura, Y. Benzyl isothiocyanate inhibits excessive superoxide generation in inflammatory leukocytes: Implication for prevention against inflammation-related carcinogenesis. Carcinogenesis 2004, 25, 567–575. Tumer, T.B.; Rojas-Silva, P.; Poulev, A.; Raskin, I.; Waterman, C. Direct and indirect antioxidant activity of polyphenol- and isothiocyanate-enriched fractions from Moringa oleifera. J. Agric. Food Chem. 2015, 63, 1505–1513
38. Tiloke, C.; Anand, K.; Gengan, R.M.; Chuturgoon, A.A. Moringa oleifera and their phytonanoparticles: Potential antiproliferative agents against cancer. Biomed. Pharmacother. 2018, 108, 457–466
39. Delelegn, A.; Sahile, S.; Husen, A. Water purification and antibacterial efficacy of Moringa oleifera Lam. Agric. Food Secur. 2018, 7, 25.
40. Fidrianny, I.; Kanapa, I.; Singgih, M. Phytochemistry and pharmacology of moringa tree: An overview. Biointerface Res. Appl. Chem. 2021, 11, 10776–10789.
41. Miyoshi, N.; Takabayashi, S.; Osawa, T.; Nakamura, Y. Benzyl isothiocyanate inhibits excessive superoxide generation in inflammatory leukocytes: Implication for prevention against inflammation-related carcinogenesis. Carcinogenesis 2004, 25, 567–575.
42. Islam Tiloke, C.; Anand, K.; Gengan, R.M.; Chuturgoon, A.A. Moringa oleifera and their phytonanoparticles: Potential antiproliferative agents against cancer. Biomed. Pharmacother. 2018, 108, 457–466
43. Tiloke, C. The Antiproliferative and Apoptosis Inducing Effects of Moringa oleifera Aqueous leaf Extract and Its Synthesised Gold Nanoparticles Modulation of Oncogenes and Tumour Suppressor Genes in Human Cancer Cell Lines; University of Kwa Zulu Natal: Berea, Durban, 2015.
44. Stohs, S.J.; Hartman, M.J. Review of the safety and efficacy of Moringa oleifera. Phyther Res. 2015, 29, 796–804.
45. Zordoky, B.N.M.; El-Kadi, A.O.S. Induction of several cytochrome P450 genes by doxorubicin in H9c2 cells. Vasc. Pharmacol. 2008, 49, 166–172.
46. Fantoukh, O.I.; Albadry, M.A.; Parveen, A.; Hawwal, M.F.; Majrashi, T.; Ali, Z.; Khan, S.I.; Chittiboyina, A.G.; Khan, I.A. Isolation, synthesis, and drug interaction potential of secondary metabolites derived from the leaves of miracle tree (Moringa oleifera) against CYP3A4andCYP2D6isozymes. Phytomedicine 2019, 60, 153010.
47. Zunica, E.R.M.; Yang, S.; Coulter, A.; White, C.; Kirwan, J.P.; Gilmore, L.A. Moringa oleifera Seed Extract Concomitantly Supplemented with Chemotherapy Worsens Tumor Progression in Mice with Triple Negative Breast Cancer and Obesity. Nutrients 2021, 13, 2923.
48. Asare, G.A.; Gyan, B.; Bugyei, K.; Adjei, S.; Mahama, R.; Addo, P.; Otu-Nyarko, L.; Wiredu, E.K.; Nyarko, A. Toxicity potentials of the nutraceutical Moringa oleifera at supra-supplementation levels. J. Ethnopharmacol. 2012, 139, 265–272.
49. Packialakshmi, N.; Archana, J. Phytochemical analysis and antibacterial activity of Moringa oleifera to treat different kinds of water samples. Int. J. Phytopharm. 2014, 5, 233–238.
50. Al-Asmari, Abdulrahman Khazim, et al. "Moringa oleifera as an anti-cancer agent against breast and colorectal cancer cell lines." *PloS one* 10.8 (2015): e0135814.
51. Charlette Tilokea,b, Krishnan Ananda, Robert M. Genganb, Anil A. Chuturgoona,∗ Moringa oleifera and their phytonanoparticles: Potential antiproliferative agents against cancer, Biomedicine & Pharmacotherapy 108(2018)457-466
52. M Vergara-Jimenez, MM Almatrafi, ML Fernandez – 2017, Bioactive components in Moringa oleifera leaves protect against chronic disease. Antioxidants, 6 (4), 1-13.

53. Kharat, Kiran, et al. "Moringa oleifera Methanolic Extract Induces Apoptosis in Human Breast Cancer Cells." *International Journal of Pharmaceutical Investigation* 12.1 (2022).
54. Parvathy, M.V.S.; Umamaheshwari, A. Cytotoxic Effect of Moringa oleifera Leaf Extracts on Human Multiple Myeloma Cell Lines. Trends Med. Res. 2007, 2, 44–50.
55. Fuel, M.; Mesas, C.; Martínez, R.; Ortiz, R.; Quiñonero, F.; Prados, J.; Porres, J.M.; Melguizo, C. Antioxidant and antiproliferative potential of ethanolic extracts from Moringa oleifera, Tropaeolum tuberosum and Annona cherimola in colorrectal cancer cells. Biomed. Pharmacother. 2021, 143, 112248.
56. Jung, I.L. Soluble extract from Moringa oleifera leaves with a new anticancer activity. PLoS ONE 2014, 9, e95492.
57. Tiloke, C.; Phulukdaree, A.; Chuturgoon, A.A. The antiproliferative effect of Moringa oleifera crude aqueous leaf extract on cancerous human alveolar epithelial cells. BMC Complement. Altern. Med. 2013, 13, 226.
58. Berkovich, L.; Earon, G.; Ron, I.; Rimmon, A.; Vexler, A.; Lev-Ari, S. Moringa oleifera aqueous leaf extract down-regulates nuclear factor-kappaB and increases cytotoxic effect of chemotherapy in pancreatic cancer cells. BMC Complement. Altern. Med. 2013, 13, 212.
59. Abd-Rabou, A.A.; Abdalla, A.M.; Ali, N.A.; Zoheir, K.M.A. Moringa oleifera root induces cancer apoptosis more effectively than leave nanocomposites and its free counterpart. Asian Pac. J. Cancer Prev. 2017, 18, 2141–2149.
60. Ghosh, N. Anticancer effect of Moringa oleifera leaf extract on human breast cancer cell. Ph.D. Thesis, Jadavpur University Kolkata, Kolkata, India, 2014.
61. Krishnamurthy, P.T.; Vardarajalu, A.; Wadhwani, A.; Patel, V. Identification and characterization of a potent anticancer fraction from the leaf extracts of Moringa oleifera L. Indian J. Exp. Biol. 2015, 53, 98–103.
62. Varalakshmi, K.; Nair, S. Anticancer, cytotoxic potential of Moringa oleifera extracts on HeLa cell line. J. Nat. Pharm. 2011, 2, 138
63. Siegel RL, Miller KD, and Jemal A. Cancer Statistics, 2017. CA Cancer J Clin. 2017; 67: 7-30.
64. Assi HA, Khoury KE, Dbouk H, Khalil LE, Mouhieddine TH, El Saghir NS. Epidemiology and prognosis of breast cancer in young women. J Thorac Dis. 2013;5(Suppl 1):S2–S8.
65. Brewer HR, Jones ME, Schoemaker MJ, et al. Family history and risk of breast cancer: an analysis accounting for family structure. Breast Cancer Res Treat. 2017; 165: 193-200
66. Metcalfe KA, Finch A, Poll A, et al. Breast cancer risks in women with a family history of breast or ovarian cancer who have tested negative for a BRCA1 or BRCA2 mutation. Br J Cancer. 2009;100(2):421–425.
67. Washbrook E. Risk factors and epidemiology of breast cancer. Women's Health Medicine. 2006; 3: 8-14.
68. Horn J, and Vatten LJ. Reproductive and hormonal risk factors of breast cancer: a historical perspective. International journal of women's health. 2017; 9: 265-272.
69. Dall GV, and Britt KL. Estrogen Effects on the Mammary Gland in Early and Late Life and Breast Cancer Risk. Front Oncol. 2017; 7: 110.
70. Horn J, Asvold BO, Opdahl S, et al. Reproductive factors and the risk of breast cancer in old age: a Norwegian cohort study. Breast Cancer Res Treat. 2013; 139: 237-243.
71. Rosato V, Bosetti C, Negri E, et al. Reproductive and hormonal factors, family history, and breast cancer according to the hormonal receptor status. Eur J Cancer Prev. 2014; 23: 412-417.
72. Brasky TM, Li Y, Jaworowicz DJ Jr, et al. Pregnancy-related characteristics and breast cancer risk. Cancer Causes Control. 2013;24(9): 1675–1685.
73. Endogenous H, Breast Cancer Collaborative G, Key TJ, et al. Sex hormones and risk of breast cancer in premenopausal women: a collaborative reanalysis of individual participant data from seven prospective studies. Lancet Oncol. 2013; 14: 1009-1019.
74. Soroush A, Farshchian N, Komasi S, et al. The Role of Oral Contraceptive Pills on Increased Risk of Breast Cancer in Iranian Populations: A Meta-analysis. Journal of cancer prevention. 2016; 21: 294-30.
75. Hamajima N, Hirose K, Tajima K, et al. Alcohol, tobacco and breast cancer--collaborative reanalysis of individual data from 53 epidemiological studies, including 58,515 women with breast cancer and 95,067 women without the disease. Br J Cancer. 2002; 87: 1234-1245.
76. Makarem N, Chandran U, Bandera EV, et al. Dietary fat in breast cancer survival. Annu Rev Nutr. 2013; 33: 319-348.
77. Knight JA, Fan J, Malone KE, et al. Alcohol consumption and cigarette smoking in combination: A predictor of contralateral breast cancer risk in the WECARE study. Int J Cancer. 2017; 141: 916-924

78. Valastyan S, and Weinberg RA. Tumor metastasis: molecular insights and evolving paradigms. Cell. 2011; 147: 275-292.
79. Prevention CfDCa. Cancer screening - United States, 2010. Morb Mortal Wkly Rep. 2012; 61: 41-45.
80. The benefits and harms of breast cancer screening: an independent review. Lancet. 2012; 380: 1778-1786.
81. van den Ende C, Oordt-Speets AM, Vroling H, et al. Benefits and harms of breast cancer screening with mammography in women aged 40-49 years: A systematic review. Int J Cancer. 2017; 141: 1295-1306.
82. Greenwood HI, Heller SL, Kim S, et al. Ductal Carcinoma in Situ of the Breasts: Review of MR Imaging Features. Radiographics. 2013; 33: 1569-1588.
83. Morrow M, Waters J, and Morris E. MRI for breast cancer screening, diagnosis, and treatment. Lancet. 2011; 378: 1804-1811.
84. Enriquez L, and Listinsky J. Role of MRI in breast cancer management. Cleve Clin J Med. 2009; 76: 525-532.
85. Saslow D, Boetes C, Burke W, et al. American Cancer Society guidelines for breast screening with MRI as an adjunct to mammography. CA Cancer J Clin. 2007; 57: 75-89.
86. Sporn MB. Approaches to prevention of epithelial cancer during the preneoplastic period. Cancer Res. 1976; 36: 2699-2702.
87. Bozovic-Spasojevic I, Azambuja E, McCaskill-Stevens W, et al. Chemoprevention for breast cancer. Cancer Treat Rev. 2012; 38: 329-339.
88. Nagini S. Breast Cancer: Current Molecular Therapeutic Targets and New Players. Anti-cancer agents in medicinal chemistry. 2017; 17: 152-163.
89. Cuzick J, Powles T, Veronesi U, et al. Overview of the main outcomes in breast-cancer prevention trials. Lancet. 2003; 361: 296-300.
90. Cuzick J, Sestak I, Bonanni B, et al. Selective oestrogen receptor modulators in prevention of breast cancer: an updated meta-analysis of individual participant data. Lancet. 2013; 381: 1827-1834.
91. Yang Y, Pan W, Tang X, et al. A meta-analysis of randomized controlled trials comparing the efficacy and safety of anastrozole versus tamoxifen for breast cancer. Oncotarget. 2017; 18: 48362-48374.
92. Elizalde PV, Cordo Russo RI, Chervo MF, et al. ErbB-2 nuclear function in breast cancer growth, metastasis and resistance to therapy. Endocr Relat Cancer. 2016; 23: 243-257.
93. Junttila TT, Akita RW, Parsons K, et al. Ligand-independent HER2/HER3/PI3K complex is disrupted by trastuzumab and is effectively inhibited by the PI3K inhibitor GDC-0941. Cancer Cell. 2009; 15: 429-440.
94. Vu T, and Claret FX. Trastuzumab: updated mechanisms of action and resistance in breast cancer. Front Oncol. 2012; 2: 62.
95. Arnould L, Gelly M, Penault-Llorca F, et al. Trastuzumab-based treatment of HER2-positive breast cancer: an antibody-dependent cellular cytotoxicity mechanism? Br J Cancer. 2006; 94: 259-267
96. Yang Y, Guo R, Tian X, et al. Synergistic anti-tumor activity of Nimotuzumab in combination with Trastuzumab in HER2-positive breast cancer. Biochemical and biophysical research communications. 2017; 489: 523-527.
97. Cameron D, Piccart-Gebhart MJ, Gelber RD, et al. 11 years' follow-up of trastuzumab after adjuvant chemotherapy in HER2-positive early breast cancer: final analysis of the HERceptin Adjuvant (HERA) trial. Lancet. 2017; 389: 1195-1205.
98. Franklin MC, Carey KD, Vajdos FF, et al. Insights into ErbB signaling from the structure of the ErbB2-pertuzumab complex. Cancer Cell. 2004; 5: 317-328.
99. Jecinta Wanjiru 1,2,*, Jeremiah Gathirwa 2, Elingarami Sauli 1 and Hulda Shaid Swai 1. Formulation, Optimization, and Evaluation of Moringa oleifera Leaf Polyphenol-Loaded Phytosome Delivery System against Breast Cancer Cell Lines. Molecules 2022, 27, 4430.