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A REVIEW ON ANTIPROLIFERATIVE ACTIVITY OF PLANT EXTRACTS AGAINST BREAST CANCER CELL LINES

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ABSTRACT: Breast cancer (BC) is the foremost cause of deaths among women worldwide. Plants contain diverse bioactive phytochemicals which have been explored by researchers all over the world for their cancer preventive potential. The present review tabulates *in-vitro* tested plants during 2014-17 against breast cancer cell line. We have collected data of 56 angiosperm families (117 plant species) which was subjected to cluster analysis. On the bases of IC_{50} values of plant extracts were clustered using cluster analysis Cluster analysis showed a grouping of order Brassicales, Fabales, Lamiales, Caryophyllales, Myrtales, and Apiales. It has been found that most of the plants tested against BC belong to eudicot group of plants. Active plant extract obtained after 24 h, 48 h and 72 h treatment were *Mimosa caesalpinnifolia*, *Ferulago angulat*, *Magydaris tomentosa*, and *Ipomea batatas* respectively. These plants may further be characterized for active ingredients to check their prospects in breast cancer treatment.

INTRODUCTION: Breast Cancer (BC) is the most prevalent cause of cancer-related deaths among women worldwide [1, 2, 3, 4, 5]. Despite advances in its diagnosis and treatment options, the number of incidences is increasing every year [6, 7]. The number of breast cancer cases reported in 2018 from the whole world was 20,88,849 amongst which 6,26,679 died [8]. BC is not just one disease but has many variations and subtypes with distinct signatures and treatment programs [9, 10].

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The early stage BC can be successfully cured, but treatment options are scarcely accessible to patients with advanced or metastatic stages [7]. Women with mutated BRCA gene, have nearly 80% risk of developing BC along with a 50% possibility of their children getting the mutated gene [11]. The genetic mutations in BRCA1 and BRCA2 genes suppurates the exigent root cause of patrimonial breast cancer [12]. Although numerous causes are associated with the establishment and progression of BC, yet the oxidative stress (OS) is operating in most of the intracellular pathways concerned with cellular proliferation [13].

It has been reported repeatedly that the level of OS is higher for BC patients as compared to healthy people due to genetic abnormalities [1, 14]. This elevated OS is beneficial for malignant cells as it

upregulates the reactive oxygen species (ROS) mediated signaling pathways which encourage cell growth, cell differentiation, glucose synthesis, protein synthesis and hence cell survival. Numerous ROS are generated within the body as a result of basal metabolic activities. Hydrogen peroxide (H_2O_2) is one such ROS which is generated during estrogen metabolism, and it is known to activate extracellular regulated kinase 1/2 (Erk 1/2). Erk 1/2 is known to promote the survival of breast cancer cells in humans by activating downstream elements [15]. Plant extracts being excellent scavengers of free radicals have often been implicated as a remedial measure in various diseases. The plant extracts contain numerous phytochemicals which act synergistically against disorders unlikely the purified compounds [16]. Numerous well established anticancer drugs in use today have been derived from plants such as Sulphoraphane, Paclitaxel, Epipodophyllotoxin, Vincristine, Vinblastin, Vinorelbine, Vindesine, Vinflunine, Pomiferin, Roscovitine, Flavopiridol, Noscapine [17, 18, 19]. In light of the significant contribution of phytochemicals in cancer treatment, the present review was designed to compile the *in-vitro* antiproliferative activity of various plant extracts against breast cancer cell line.

2. MATERIALS AND METHODS:

2.1. Database Search: We have searched online free resource "PubMed" (maintained by National Center for Biotechnology Information at the National Library of Medicine, USA) for plants extracts assessed for their antiproliferative activity against breast cancer cell line (MCF-7) employing *in-vitro* assays (MTT, MTS, XTT, CCK-8, SRB, CVS, WST-1, ATPlite, Alamar blue, Methylene blue, RTCA MP) for treatment period of 24, 48 and 72 h. The data was collected for the last four years *i.e*, 2014-17.

2.2. Presentation of Collected Data: The collected data was presented in the tabulated form. Various parameters selected for the present work were a plant, family, plant part used, the solvent used for extraction, assay employed and IC_{50} concentration.

2.3. Data Analysis: Cluster analysis was done by using PAST software applying Ward's method, and Euclidian distance was calculated and presented as a measure of similarity.

3. RESULTS AND DISCUSSION:

3.1. Families and Orders: The collected data covered 56angiosperm families and 118 plants **Table 1**. From these, 50 families belong to eudicots (22 orders), 4 families belong to monocots (4 orders), and 2 families belong to magnoliids (2 orders) as shown in **Table 2**.

3.2. Cluster Analysis (CA): The CA was applied to IC_{50} values of different plant species (as reported in the respective research paper) on the basis of above-ground plant part with treatment time of 24 (AG24), 48 (AG48) & 72 h (AG72); below ground with treatment period of 24 h (BG24).

TABLE 1: PLANT SPECIES TESTED AGAINST MCF-7 BREAST CANCER CELL LINE DURING 2014-18

S. no.	Family	Plant	Plant part	Solvent	Assay	Treatment time (H)	IC_{50} (µg/ml)
1	Acanthaceae	*Clinacanthus nutans* [32]	Root	MeOH	MTT	24	35
		Avicennia alba[33]	Leaves	MeOH	MTT	48	117
		Ecbolium virde[33]	Leaves	MeOH	MTT	48	60
		Phlogacanthus thyrsiformis[34]	Leaves	EtOH	MTT	24	49
2	Anacardiaceae	*Mangifera indica*[35]	Kernal	EtOH	MTT	72	15
		Lannea coromandelica[33]	Bark	MeOH	MTT	48	270
			Leaves	MeOH	MTT	48	161
3	Apiaceae	*Glehnia littoralis*[36]	Root	AQ	CCK-8	24	158.63
		Ferula heuffelii[37]	Undergroun	CF	MTT	24	6.1
			d Parts	MeOH	MTT	24	47.6
4	Apocynaceae	*Leptadenia reticulata*[38]	Whole plant	AQ	MTT	24	740
		Picralima nitida[39]	Root Bark	EtOH	MTS	24	22.76
		Holarrhena floribunda[40]	Leaves	MeOH	MTT	24	357.6
						48	244.3
						72	126.7
		Hemidesmus indicus[41]	Root	AQ	MTT	24	829.32

				30% EtOH	MTT	24	209.73
5	Araliaceae	*Hedera nepalensis*[42]	Aerial Part	MeOH+ CF	SRB	72	62
6	Asteraceae	*Vernonia cinerea*[43]	Whole plant	EtOH	SRB	72	60
		Gnaphalium luteoalbum[33]	Leaves	MeOH	MTT	48	340
		Artemisia indica[34]	Leaves	95% EtOH	MTT	24	48
		Launaea procumbens[44]	Leaves	MeOH	MTT	48	> 80
		Sphaeranthus amaranthoide[45]	Whole plant	PE	MTT	48	23.55
		Anthemis mirheydari[46]	Whole plant	DCE	MTT	72	25.2
7	Berberidaceae	*Berberis orthobotrys*[39]	Root	MeOH	MTS	24	81.35
8	Bignoneaceae	*Tabebuia impetigosa*[47]	Dried inner bark	MeOH	SRB	24	110.76
9	Cactaceae	Opuntia ficus-indica[48]	Stem	EA	MTT	48	138
10	Capparaceae	*Crateva adansonii*[49]	Stem Bark	DCM + MeOH	ABA	24	289
11	Caprifoliaceae	*Nardostachys jatamansi*[50]	Roots + Rhizome	MeOH	MTT	48	58.01
				PE	MTT	48	60.59
12	Caryophyllaceae	*Arenaria montana*[51]	Aerial part	AQ	SRB	48	130.05
13	Chrysobalanaceae	*Licania rigida*[52]	Seeds	EtOH	ATPlite	24	N.C
		Licania tomentosa[52]	Seeds	EtOH	ATPlite	24	N.C
14	Combretaceae	*Anogeissus latifolia*[53]	Stem & Leaves	95% EtOH	MTT	48	20.1
		Terminalia bellerica[53]	Stem & Bark	95% EtOH	MTT	48	9
		Terminalia bellerica[54]	Fruits	70% MeOH	WST-1	48	104.65
		Terminalia chebula[55]	Leaf galls	EtOH	MTT	72	208.16
15	Convolvulaceae	*Ipomoea batatas*[56]	Peeled Root tubers	Acidified EtOH	MTT	24	5.9
			Not Peeled Root tubers	Acidified EtOH	MTT	24	4.9
16	Cucurbitaceae	*Momordica cochinchinensis*[57]	Aril	Hexane+ Acetone + EtOH	MTT	48	117
17	Dilleniaceae	*Dillenia suffruticosa*[58]	Root	DCE	MTT	24	20.3
		Dillenia suffruticosa[59]	Root	EA	MTT	24	76
		Dillenia indica[33]	Leaves	MeOH	MTT	48	340
18	Dioscoreaceae	*Dioscorea villosa*[60]	Root	MeOH	CC	72	27
19	Dipterocarpaceae	*Dipterocarpus turbinatus*[33]	Bark	MeOH	MTT	48	168
20	Droseraceae	*Drsera burmanni*[61]	Whole plant	MeOH	WST-1	48	120.94
21	Ebenaceae	*Diospyros peregrina*[33]	Leaves	MeOH	MTT	48	7
22	Ericaceae	*Vaccinium bracteatum*[62]	Leaves	Hexane	RTCA MP	72	206.75
23	Euphorbiaceae	*Jatropha curcas*[39]	Root Bark	EtOH	MTS	24	36.55
		Jatropha gossypifolia[39]	Root Bark	EtOH	MTS	24	25.55
		Croton sphaerogynus[63]	Leaves	EtOH	SRB	48	53.4
24	Fabaceae	*Eythrina excelsa*[64]	Stem Bark	EtOH	MTT	24	13.6
		Acacia catechu[53]	Fruit	50% EtOH	MTT	48	22.8
		Acacia catechu[54]	Heartwood	70% MtOH	MTT	48	288.85
		Enterolobium cyclocarpum[65]	Leaves	MeOH	MTT	48	11.84
		Sophora interrupta[66]	Root	EA	MTT	24	250
		Caesalpinia pulcherrima[33]	Leaf	MeOH	MTT	48	240
		Clitoria ternatea[33]	Flower	MeOH	MTT	48	114
			Leaf	MeOH	MTT	48	170
		Alhagi graecorum[67]	Aerial Part	85% EtOH	CVA	48	36.4
		Saraca indica[68]	Bark	80% MtOH	MTT	72	73.6
		Pithecellobium dulce[16]	Leaf	AQ	MTT	24	400
						48	300
		Mimosa caesalpiniifolia[69]	Leaves	70% EtOH	MTT	24	5
25	Geraniaceae	*Pelargonium sidoides*[70]	Root	AQ +	SRB	72	43

				Alcohol			
26	Hypericaceae	*Hypericum adenotrichum*[71]	Aerial part	MeOH	MTT	72	10.9
27	Icacinaceae	*Pyrenacantha standtii*[72]	Leaves	EtOH	MTS	24	37.36
28	Lamiaceae	*Teucrium polium*[73]	Leaves	MeOH	MTT	48	35
			Flower	MeOH	MTT	48	20
		Lavandula dentata[74]	Whole plant	EtOH	MTT	24	39
		Coridothymus capitatus[75]	Aerial part	EtOH	MTT	24	100
		Lavandula angustifolia[76]	Aerial part	Hexane	MTS	24	85.68
				EtOH	MTS	24	179.6
		Stachys acerosa[77]	Aerial part	DCM	MTT	72	160.3
		Stachys benthamiana[77]	Aerial part	DCM	MTT	72	71.1
				MeOH	MTT	72	162.4
		Stachys byzantina[77]	Aerial part	DCM	MTT	72	131
		Stachys lavandulifolia[77]	Aerial part	DCE	MTT	72	81.2
				80% MeOH	MTT	72	151.7
		Stachys persica[77]	Aerial part	80% MeOH	MTT	72	104.1
		Stachys pilifera[77]	Aerial part	DCM	MTT	72	40.9
		Stachys pubescens[77]	Aerial part	DCM	MTT	72	103.3
				MeOH	MTT	72	146.5
		Stachys spectabilis[77]	Aerial part	DCM	MTT	72	65.2
		Melissa officinalis[78]	Leaves	AQ	MTT	48	51
		Nepeta cataria[79]	Aerial part	MeOH	ABA	48	> 500
		Salvia chorassavica[80]	Root	MeOH	ABA	48	13
29	Lauraceae	*Cinnamomum cassia*[81]	Bark	Hexane	MTT	24	34
30	Lecythidaceae	*Barringtonia racemosa*[82]	Fruit	MeOH	MTT	48	57.61
31	Loranthaceae	*Plicosepalus curviflorus*[83]	Leaves	MeOH	CVS	48	20.9
		Macrosolen parasiticus[84]	Stem	MeOH	MTT	48	97.33
				MeOH	SRB	48	51.9
				AQ	MTT	48	59.33
				AQ	SRB	48	94.58
32	Malvaceae	*Theobroma cacao*[85]	Leaf	MeOH	MTT	24	41.4
			Bark	MeOH	MTT	24	72
			Root	MeOH	MTT	24	76.4
		Abutilon theophrasti[86]	Aerial Part	MeOH	MTT	24	505.8
		Ceiba pentandra[87]	Stem Bark	PE	MTT	48	152.17
						72	330.85
		Hibiscus sabdariffa[82]	Fruit	MeOH	MTT	48	112.1
33	Melastomataceae	*Melastoma malabathricum*[88]	Leaves	MeOH	MBA	72	7.14
			Flower	MeOH	MBA	72	33.63
34	Molluginaceae	*Glinus oppositifolius*[33]	Whole plant	MeOH	MTT	48	150
35	Moraceae	*Ficus cyathistipula*[89]	Leaves	Aqueous	SRB	48	30
				EtOH	SRB	48	18
36	Moringaceae	*Moringa oliferna*[53]	Leaves	50% EtOH	MTT	48	26.4
		Moringa oliferna[90]	Essential oil	CP	MTT	24	226.1
37	Myricaceae	*Myrica nagi*[33]	Leaves	MeOH	MTT	48	172
38	Myrtaceae	*Syzygium aromaticum*[91]	Cloves	EtOH	MTT	48	455
		Pimenta dioica[92]	Berries	AQ	MTT	72	50
39	Oleaceae	*Fraxinus micrantha*[93]	Dried Bark	MeOH	MTT	24	18.95
		Jasminum sambac[33]	Leaves	MeOH	MTT	48	7
40	Papaveraceae	*Chelidonium majus*[94]	Whole plant	EtOH	MTT	24	179.35
						48	44.65
		Fumaria vaillantii[95]	Aerial part	80% EtOH	MTT	24	90
						48	20
						72	2
41	Phyllanthaceae	*Flueggea leucopyrus*[96]	Aerial part	AQ	SRB	24	27.89
42	Piperaceae	*Piper cubeba*[97]	Seeds	MeH	MTT	72	22.31
				DCM	MTT	72	62.2
		Piper nigrum[98]	Seeds	93% EtOH	MTT	24	27.1
43	Poaceae	*Cymbopogon citratus*[99]	Leaves	50% EtOH	MTT	48	68
				90% EtOH	MTT	48	104.6

44	Potenderiaceae	*Eichhornia crassipes*[100]	Whole Plant	MeOH	SRB	72	1.2
45	Primulaceae	*Aegiceras corniculatum*[33]	Fruit	MeOH	MTT	48	91
		Maesa macrophylla[34]	Leaves	95% EtOH	MTT	24	22.66
46	Punicaceae	*Punica granatum*[101]	Fruit	Fruit Juice	MTT	72	50
47	Resedaceae	*Ochradenus arabicus*[74]	Aerial part	95% EtOH	MTT	24	562
48	Rhamnaceae	*Ziziphus spina-christi*[102]	Leaves	80% EtOH	MTT	24	230
49	Rubiaceae	*Hymenodictyon excelsum*[33]	Bark	MeOH	MTT	48	80
			Wood	MeOH	MTT	48	72
		Mussaenda glabrata[33]	Leaves	MeOH	MTT	48	133
		Galium aparine[103]	Whole plant	MeOH	XTT	72	503
50	Rutaceae	*Glycosmis pentaphylla*[104]	Leaves	PE	SRB	48	95.5
51	Salicaceae	*Casearia sylvestris*[105]	Leaves	AQ EtOH	MTT	24	141
52	Solanaceae	*Capsicum annuum*[106]	Seeds	AQ	CPC	120	14.7
53	Thymelaeaceae	*Phaleria macrocarpa*[107]	Fruit	AQ MeOH	MTT	24	96
			Seed	AQ MeOH	MTT	24	12
54	Urticaceae	*Urtica pilulifera*[75]	Aerial part	EtOH	MTT	24	63
55	Verbenaceae	*Lantana camara*[108]	Whole plant	EtOH	MTT	24	32.39
		Clerodendrum viscosum[33]	Leaves	MeOH	MTT	48	50
56	Zingiberaceae	*Curcuma zedoaria*[109]	Rhizome	Hexane	MTT	72	18.4
		Etlingera elatior[110]	Flowers	Water + EtOH	MTT	72	173.1
		Alpinia galanga[111]	Rhizome	EtOH	MTT	72	170
		Curcuma kwangsiensis[112]	Rhizome	HD	MTT	24	82.3

N.C = Not Cytotoxic; MeOH = Methanol; EtOH = Ethanol; DCM = Dichloromethane; DCE = Dichloroethane; PE = Petroleum ether; EA = Ethyl Acetate; ABA = Alamar Blue Assay; CC = Cell Counting; CVA = Crystal Violet Assay; MBA = Methylene Blue Assay; CPC = Coulter particle counter; AQ = Aqueous; CF = Chloroform; HD = Hydrodistillation; CP = Cold Pressing; CPC = Coulter particle counter; MBA = Methylene blue assay.

TABLE 2: NUMBER OF ORDERS AND FAMILIES OF PLANT SPECIES (TESTED AGAINST BREAST CANCER CELL LINE) BELONGING TO VARIOUS APG CLADES

S. no.	APG Clade	No. of orders	No. of families	No. of plants
1	Eudicots	22	50	108
2	Monocots	04	04	07
3	Magnoliids	02	02	03

3.2.1. CA of AG24: AG24 involved 31 plant species belonging to 23 families. The CA of AG24 revealed a clustering of *Crateva adansonii* (Capparaceae) with *Moringa oliferna* (Moringaceae) both belonging to order Brassicales and *Mimosa caesalpiniifolia* with *Eythrina excelsa* which belong to family Fabaceae and order Fabales **Fig. 1**. The minimum IC_{50} value was found in *Momosa caesalpiniifolia* (5.0 µg/ml) while maximum IC_{50} in *Leptadenia reticulata* (740 µg/ml).

3.2.2. CA of AG48: AG48 involved 44 plants belonging to 31 families. The CA of AG48 showed clustering of *Clerodendrum viscosum* (Verbenaceae) with *Melissa officinalis* (Lamiaceae), both belonging to order Lamiales. Clustering was also observed in plants of Caryophyllales order *i.e, Opuntia ficus-indica* (Cactaceae) with *Arenaria montana* (Caryophyllaceae) **Fig. 2**. The minimum IC_{50} value was found in *Ferulago angulata* (5.3 µg/ml) while maximum IC_{50} in *Syzygium aromaticum* (455 µg/ml).

3.2.3. CA of AG72: The AG72 group had 27 plants which were spread across 16 families. The CA presented aggregation of families belonging to order Lamiales and Myrtales. The plants belonging to order lamiales were *Stachys persica*, *Stachys pubescens* and *Stachys byzantinai*.

Order Myrtales included *Pimenta dioica* and *Punica granatum* **Fig. 3**. The minimum IC_{50} value was found in *Magydaris tomentosa* (0.94 µg/ml) while maximum IC_{50} in *Galium aparins* (503 µg/ml).

3.2.4. CA of BG24: The BG24 group included 13 plants belonging to 10 families. The CA showed grouping of *Glehnia littotalis* and *Hemidesmus indicus* belonging to family Apiaceae and order Apiales **Fig. 4**.

The minimum IC_{50} value was found in *Ipomoea batatas* (5.9 µg/ml) while maximum IC_{50} in *Sophora interrupta* (250 µg/ml).

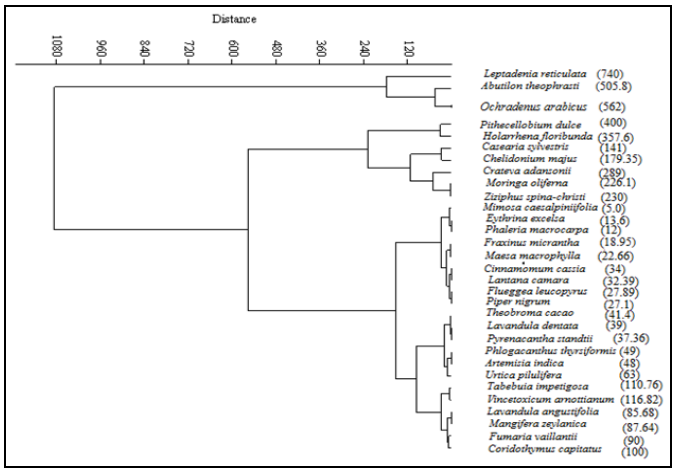

FIG. 1: CLUSTER ANALYSIS OF ABOVE GROUND PLANT PARTS WITH TREATMENT PERIOD OF 24 h (AG24) ALONG WITH THEIR IC_{50} VALUE (µg/ml)

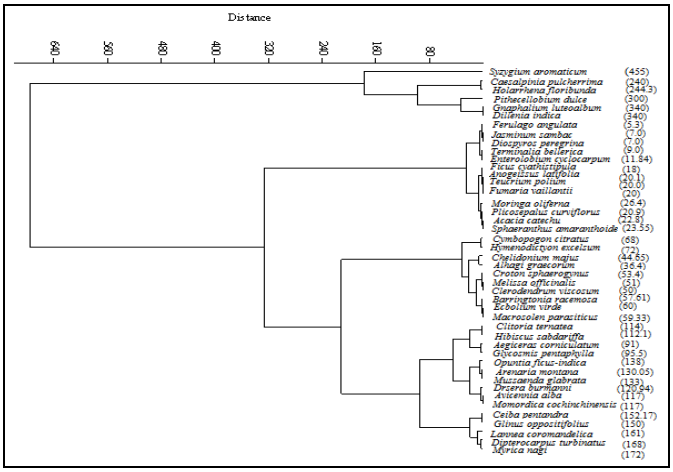

FIG. 2: CLUSTER ANALYSIS OF ABOVE GROUND PLANT PARTS WITH TREATMENT PERIOD OF 48 h (AG48) ALONG WITH THEIR IC_{50} VALUE (µg/ml)

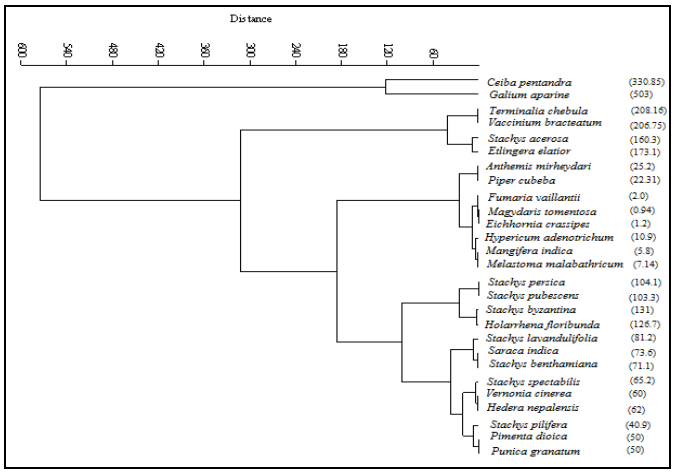

FIG. 3: CLUSTER ANALYSIS OF ABOVE GROUND PLANT PARTS WITH TREATMENT PERIOD OF 72 h (AG72) ALONG WITH THEIR IC_{50} VALUE (µg/ml)

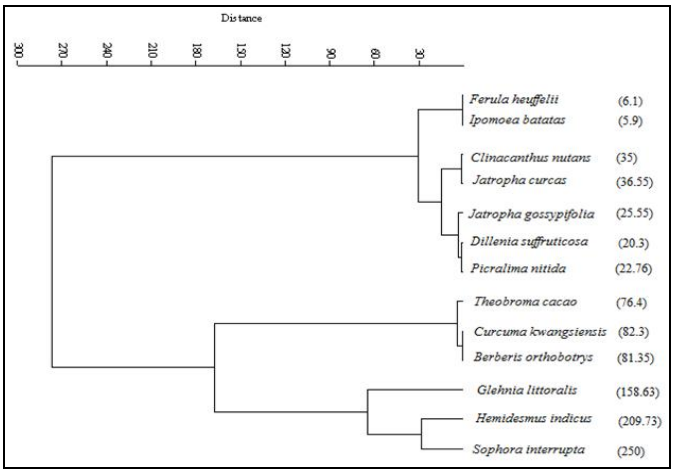

FIG. 4: CLUSTER ANALYSIS OF BELOW GROUND PLANT PARTS WITH TREATMENT PERIOD of 24 h (BG24) ALONG WITH THEIR IC_{50} VALUE (µg/ml)

3.3. Assay Reported: The *in-vitro* tetrazolium and resazurin-based reduction assays employed by authors were MTT (3-(4,5-Dimethylthiazol-2-Yl)-2,5-Diphenyltetrazolium Bromide); CCK-8 (Cell counting kit-8); MTS (3-(4,5-dimethylthiazol-2-yl)-5- (3-carboxymethoxyphenyl)- 2- (4-sulfophenyl)-2H-tetrazolium, inner salt); XTT (2,3-bis(2-methoxy-4-nitro-5-sulphophenyl)-5-carboxanilide-2H-tetrazolium, monosodium salt); SRB (Sulforhodamine B colorimetric assay); ABA (Alamar blue assay); WST (2-(4-iodophenyl)-3-(4-nitrophenyl)-5-(2,4-disulfophenyl)-2H-tetrazolium, monosodium salt); Luminogenic ATP (Adenosine triphosphate); RTCA-MP (real-time cell impedance-based cell growth method); CVA (Crystal violet staining).

3.4. Causes of Breast Cancer: There are numerous causes of breast cancers as conversed in proceeding discussion. Elderly women are at more risk of developing breast cancer as compared to younger women [20]. Post-menopausal women develop a greater threat of having breast cancer, which doubles with every passing decade to 80 years of life [21]. The risk of getting breast cancer is reduced by bearing a child. This has been justified by the lower rates of incidences in married women as compared to single women [22]. The reason may be early differentiation of mammary stem cells which belittles the threat of developing breast cancer [23].

Mutations in certain high penetrance genes like RCA1, BRCA2, PTEN, TP53, CDH1, and STK11and lower penetrance genes (CHEK2, BRIP1, ATM, and PALB2) are responsible for breast cancer incidences [24, 25]. Long term or frequent exposure to polycyclic aromatic hydrocarbons (PAHs) disrupt estrogen metabolism and induce mammary cancer [26].

Most of the ovarian hormones taken after menopause to allay its effects increase the rate of breast cancer induction in postmenopausal women [27]. Increased alcohol consumption in women is also linked with breast cancer incidences [28]. Lanky lifestyle like persistent obesity and unhealthy dietary intake is associated with breast cancer [29].

Exposure to ionizing radiations especially during breast development elevates the risk of developing breast cancer which can be avoided by lessening repetitive needless testing [29, 30]. Lopsided work schedule of women in developing as well as developed nations have also been positively correlated to increased breast cancer incidences [31]. **Table 3** and **Fig. 5** compares the number of breast cancer cases reported their percentage of mortality in different countries.

TABLE 3: BREAST CANCER INCIDENCES REPORTED AND PERCENTAGE of CANCER DEATHS IN DIFFERENT COUNTRIES (GLOBOCAN 2014)

Country	Population	Breast cancer	% of breast cancer death cases
India	124×10^7	144937	21.5
Bangladesh	155×10^6	14836	16.9
Afgganistan	29825000	3108	22.8
Australia	23050000	14710	17.3
China	139×10^7	187213	-
France	63937000	54245	19.9
Germany	82800000	71623	18.8
Italy	60885000	50658	18.2
Japan	1.27×10^6	55710	9.2
Pakistan	1.79×10^6	34038	30.8
South Africa	52386000	9815	16
Sri Lanka	21098000	3955	18.8
USA	318×10^6	232714	16.1

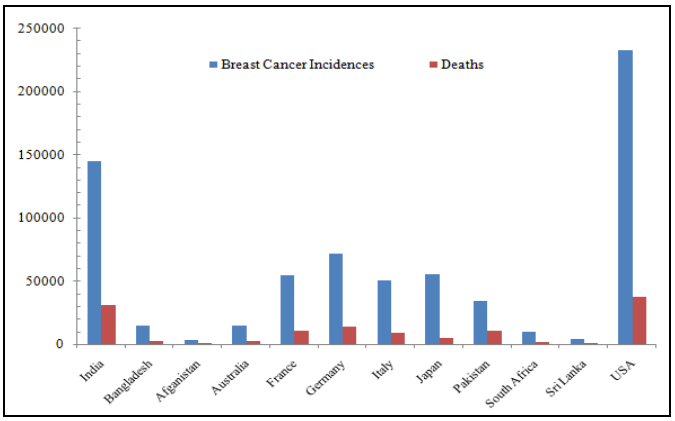

FIG. 5: NUMBER OF BREAST CANCER PATIENTS REPORTED AND PERCENTAGE CAUSALITIES IN DIFFERENT COUNTRIES

CONCLUSION: It has been concluded that most of the plants tested against breast cancer cell line belong to eudicots. Above ground plant parts showed better antiproliferative activity as compared to below ground plant parts. Active plant extract obtained after 24 h, 48 h and 72 h treatment were *Mimosa caesalpinnifolia*, *Ferulago angulat*, *Magydaris tomentosa*, and *Ipomea batats*. These plants must be characterized for active ingredients which can further be used *in-vivo* studies in animals induced with breast cancer to find out their prospects in breast cancer treatment.

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REFERENCES:

1. Cuchra M, Mucha B, Markiewicz L, Przybylowska-Sygut K, Pytel D, Jeziorski A, Kordek R and Majsterek I: The role of base excision repair in the pathogenesis of breast cancer in the Polish population. Molecular Carcinogenesis 2016; 55: 1899-14.
2. Harbeck N and Gnant M: Breast cancer. Lancet 2017; 18(389): 1134-50.
3. Mistry DA and French PW: Circulating Phospholipids as Biomarkers of Breast Cancer: A Review. Breast Cancer 2016; 10: 191-96.
4. Pritchard KI, Chia SK, Simmons C, McLeod D, Paterson A, Provencher L and Rayson D: Enhancing endocrine therapy combination strategies for the treatment of postmenopausal HR+/HER2–advanced breast cancer. The Oncologist 2017; 22(1): 12-24.
5. Sana T, Siddiqui BS, Shahzad S, Farooq AD, Siddiqui F, Sattar S and Begum S: Antiproliferative Activity and Characterization of Metabolites of *Aspergillus nidulans*: an endophytic fungus from *Nyctanthes arbor-tristis* Linn. against three human cancer cell lines. Medicinal chemistry (Shariqah (United Arab Emirates). Doi 10.2174/1573406414666180828124252
6. Mondal A and Bennett LL: Resveratrol enhances the efficacy of sorafenib mediated apoptosis in human breast cancer MCF7 cells through ROS, cell cycle inhibition, caspase 3 and PARP cleavage. Biomedicine Pharmacotherapy 2016; 84: 1906-1914.
7. Kosaloglu Z, Bitzer J, Halama N, Huang Z, Zapatka M, Schneeweiss A, Jäger D and Zörnig I: *In-silico* SNP analysis of the breast cancer antigen NY-BR-1.BMC Cancer 2016; 16: 901.
8. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA and Jemal A: Global Cancer Statistics 2018: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA: A Cancer Journal for Clinicians 2018; 68(6): 394-24.
9. Kumar M, De-Vaux RS and Herschkowitz JI: Molecular and cellular changes in breast cancer and new roles of lnc RNAs in breast cancer initiation and progression. Progress

in Molecular Biology & Translational Science 2016; 144: 563-86.
10. Chen Y, Wang X, Wang G, Li Z, Wang J, Huang L and Yin Y: Integrating multiple omics data for discovery of potential beclin-1 interactors in breast cancer. Molecular BioSystems 2017; 13: 991-99.
11. Rowlan E, Plumridge G, Considine AM and Metcalfe A: Preparing young people for future decision-making about cancer risk in families affected or at risk from hereditary breast cancer: A qualitative interview study.European Journal of Oncology Nursing 2016; 25: 9-15.
12. Fabian P and Nenutil R: Breast cancer in BRCA1/2 mutation carriers. Czechoslovak Patho 2016; 52: 206-209.
13. Sanches LJ, Marinello PC, Panis C, Fagundes TR, Morgado-Díaz JA, de-Freitas-Junior JCM and Luiz RC: Cytotoxicity of citral against melanoma cells: The involvement of oxidative stress generation and cell growth protein reduction. Tumor Biology 2017; 39(3): 1010428317695914.
14. Cramer SL, Saha A, Liu J, Tadi S, Tiziani S, YanW, Triplett K, Lamb C, Alter SE, Rowlinson S, Zhang YJ, Keating MJ, Huang P, DiGiovanni J, Georgiou G and Stone E: Systemic depletion of L-cyst(e)ine with cyst(e)inase increases reactive oxygen species and suppresses tumor growth. Nature Medicine 2016; 23: 120-27.
15. Fink MY and Chipuk JE: Survival of HER2-Positive Breast Cancer Cells. Genes and Cancer. 2013. 4: 187-195.
16. Sharma M: Selective cytotoxicity and modulation of apoptotic signature of breast cancer cells by Pithecellobium dulce leaf extracts. Biotechnology progress 2016; 32: 756-66.
17. Greenwell M and Rahman PKSM: Medicinal plants: their use in anticancer treatment. International Journal of Pharmaceutical Sciences and Research 2015; 6(10): 4103.
18. Pereira A, Bester M, Soundy P and Apostolides Z: Anti-proliferative properties of commercial Pelargonium sidoides tincture, with cell-cycle G0/G1 arrest and apoptosis in Jurkat leukaemia cells. Pharmaceutical Biology 2016; 54(9): 1831-40.
19. Basu P and Maier C: Phytoestrogens and breast cancer: *In-vitro* anticancer activities of isoflavones, lignans, coumestans, stilbenes and their analogs and derivatives. Biomedicine & Pharmacotherapy 2018; 107: 1648-1666.
20. AIHW: Breast Cancer in Australia: An Overview. Cancer series no. 71. Cat. no. CAN 67. Canberra: Australian Institute of Health and Welfare & Cancer Australia 2012.
21. Newcomb PA and Wernli KJ: Risk Factors. In: Sauter E, DalyM (eds) Breast cancer risk reduction and early detection. Springer, New York 2010; 3-22.
22. MacMahon B: Epidemiology and the causes of breast cancer. International Journal of Cancer 2006; 118(10): 2373-78.
23. Willett W: The search for the causes of breast and colon cancer. Nature 1989; 338(6214): 389.
24. Shiovitz S and Korde LA: Genetics of breast cancer: a topic in evolution. Annals of Oncology 2015; 26(7): 1291-99.
25. Malvia S, Bagadi SA, Dubey US and Saxena S: Epidemiology of breast cancer in Indian women. Asia-Pacific Journal of Clinical Oncology 2017; 13(4): 289-95.
26. Rodgers KM, Udesky JO, Rudel RA and Brody JG: Environmental chemicals and breast cancer: an updated review of epidemiological literature informed by biological mechanisms. Environmental Research 2018; 160: 152-82.
27. Azam S, Lange T, Huynh S, Aro AR, von Euler-Chelpin M, Vejborg I and Andersen ZJ: Hormone replacement therapy, mammographic density, and breast cancer risk: a cohort study. Cancer Causes and Control 2018; 29(6): 495-05.
28. Connor J: Alcohol consumption as a cause of cancer. Addiction 2017; 112(2): 222-28.
29. McPherson K, Steel CM and Dixon JM: 5 Breast cancer-epidemiology, risk factors, and genetics.ABC of Breast Diseases 2009; 572: 24.
30. Smith-Bindman R: Environmental causes of breast cancer and radiation from medical imaging: findings from the Institute of Medicine report. Archives of Internal Medicine 2012; 172(13): 1023-1027.
31. Hansen J: Increased breast cancer risk among women who work predominantly at night. Epidemiology 2001; 12(1): 74-77.
32. Teoh PL, Cheng AYF, Liau M, Lem FF, Kaling GP, Chua FN and Cheong BE: Chemical composition and cytotoxic properties of *Clinacanthus nutans* root extracts. Pharmaceutical Biology 2017; 55: 394-01.
33. Akter R, Uddin SJ, Grice ID and Tiralongo E: Cytotoxic activity screening of Bangladeshi medicinal plant extracts. Journal of natural medicines 2014; 68: 246-52.
34. Tiwary BK, Bihani S, Kumar A, Chakraborty R and Ghosh R: The *in-vitro* cytotoxic activity of ethnopharmacological important plants of Darjeeling district of West Bengal against different human cancer cell lines. BMC complementary and alternative medicine 2015; 15: 22.
35. Abdullah ASH, Mohammed AS, Abdullah R, Mirghani MES and Al-Qubaisi M: Cytotoxic effects of *Mangifera indica* L. kernel extract on human breast cancer (MCF-7 and MDA-MB-231 cell lines) and bioactive constituents in the crude extract. BMC complementary and alternative medicine 2014; 14: 1-10.
36. de la Cruz JF, Vergara EJ, Cho Y, Hong HO, Oyungerel B and Hwang SG: *Glehnia littoralis* root extract induces G0/G1 Phase Cell Cycle Arrest in the MCF-7 Human Breast Cancer Cell Line. Asian Pacific Journal of Cancer Prevention 2014; 16: 8113-17.
37. Pavlović I, Petrović S, Milenković M, Stanojković T, Nikolić D, Krunić A and Niketić M: Antimicrobial and cytotoxic activity of extracts of *Ferula heuffelii* Griseb.ex Heuff. and its metabolites. Chemistry & biodiversity 2015; 12: 1585-94.
38. Mohanty SK, Mallappa KS, Godavarthi A, Subbanarasiman B and Maniyam, A: Evaluation of antioxidant, *in-vitro* cytotoxicity of micropropagated and naturally grown plants of *Leptadenia reticulata* (Retz.) Wight & Arn.-an endangered medicinal plant. Asian Pacific journal of tropical medicine 2014; 7: S267-S271.
39. Engel N, Falodun A, Kühn J, Kragl U, Langer P and Nebe B: Pro-apoptotic and anti-adhesive effects of four African plant extracts on the breast cancer cell line MCF-7. BMC Complementary and Alternative Medicine 2014; 14: 1-13.
40. Badmus JA, Ekpo OE, Hussein AA, Meyer M and Hiss DC: Antiproliferative and apoptosis induction potential of the methanolic leaf extract of *Holarrhena floribunda* (G. Don). Evidence-Based Complementary and Alternative Medicine 2015. doi.org/10.1155/2015/756482.
41. Statti G, Marrelli, M, Conforti F, Spagnoletti A, Tacchini M, Fimognari C and Guerrini A: Inhibition of cancer cell proliferation and antiradical effects of decoction, hydroalcoholic extract, and principal constituents of *Hemidesmus indicus* R. Br. Phytotherapy Research 2015; 29: 857-63.

42. Jafri L, Saleem S, Kondrytuk TP, Haq IU, Ullah N, Pezzuto JM and Mirza B: *Hedera nepalensis* K. Koch: A novel source of natural cancer chemopreventive and Anticancerous Compounds. Phytotherapy Research 2016; 30: 447-53.
43. Beeran AA, Maliyakkal N. Rao CM and Udupa N: The enriched fraction of *Vernonia cinerea* L. induces apoptosis and inhibits multi-drug resistance transporters in human epithelial cancer cells. Journal of Ethnopharmacology 2014; 158: 33-42.
44. Rawat P, Saroj LM, Kumar A, Singh TD, Tewari SK and Pal M: Phytochemicals and cytotoxicity of *Launaea procumbens* on human cancer cell lines. Pharmacognosy Magazine 2016; 12: S431.
45. Gayatri,S, Suresh R, Reddy CUM and Chitra K: Isolation and characterization of the chemopreventive agent from *Sphaeranthus amaranthoides* Burm F. Pharmacognosy research 2016; 8: 61-65.
46. Jassbi AR, Firuzi O, Miri R, Salhei S, Zare S, Zare M, and Baldwin IT: Cytotoxic activity and chemical constituents of *Anthemis mirheydari*. Pharmaceutical biology 2016; 54: 2044-49.
47. Pires TC, Dias MI, Calhelha RC, Carvalho AM, Queiroz, MJR, Barros L and Ferreira IC: Bioactive Properties of *Tabebuia impetiginosa*-based phytopreparations and phytoformulations: a comparison between extracts and dietary supplements. Molecules 2015; 20: 22863-71.
48. Kim J, Soh SY, Shin J, Cho CW, Choi YH and Nam SY: Bioactives in cactus (*Opuntia ficus-indica*) stems possess potent antioxidant and pro-apoptotic activities through COX-2 involvement. Journal of the Science of Food and Agriculture 2015; 95: 2601-06.
49. Zingue S, Cisilotto J, Tueche AB, Bishayee A, Mefegue FA, Sandjo LP and Awounfack CF: *Crateva adansonii* DC, an African ethnomedicinal plant, exerts cytotoxicity *in-vitro* and prevents experimental mammary tumorigenesis *in-vivo*. Journal of Ethnopharmacology 2016; 190: 183-99.
50. Chaudhary S, Chandrashekar KS, Pai KSR, Setty MM, Devkar RA, Reddy ND and Shoja MH: Evaluation of antioxidant and anticancer activity of extract and fractions of *Nardostachys jatamansi* DC in breast carcinoma. BMC Complementary and Alternative Medicine 2015; 15: 1.
51. Pereira E, Barros L, Calhelha RC, Dueñas M, Carvalho AM, Santos-Buelga C and Ferreira IC: Bioactivity and phytochemical characterization of *Arenaria montana* L. Food & function 2014; 5: 1848-55.
52. Parra-Pessoa I, Lopes-Neto JJ, Silva de Almeida T, Felipe-Farias D, Vieira LR, Lima de Medeiros J and Carvalho AFU: Polyphenol composition, antioxidant activity and cytotoxicity of seeds from two underexploited wild Licania species: *L. rigida* and *L. tomentosa*. Molecules 2016; 21: 1755.
53. Diab KA, Guru SK, Bhushan S and Saxena AK: *In-vitro* anticancer activities of *Anogeissus latifolia, Terminalia bellerica, Acacia catechu* and *Moringa oleiferna* Indian plants. Asian Pacific Journal of Cancer Prevention 2015; 16: 6423-28.
54. Ghate NB, Hazra B, Sarkar R, Chaudhuri D and Mandal N: Alteration of Bax/Bcl-2 ratio contributes to *Terminalia belerica*-induced apoptosis in human lung and breast carcinoma. *In-vitro* Cellular & Developmental Biology-Animal 2014; 50: 527-37.
55. Shankara BR, Ramachandra YL, Rajan SS, Ganapathy PS, Yarla NS, Richard SA and Dhananjaya BL: Evaluating the anticancer potential of ethanolic gall extract of *Terminalia chebula* (Gaertn.) Retz. (Combretaceae). Pharmacognosy Research 2016; 8: 209-12.
56. Sugata M, Lin CY and Shih YC: Anti-Inflammatory and anticancer activities of Taiwanese purple-fleshed sweet potatoes (*Ipomoea batatas* L. Lam) Extracts. BioMed Research International 2015. doi.org/10.1155/2015/768093
57. Petchsak P and Sripanidkulchai B: *Momordica cochinchinensis* aril extract induced apoptosis in human MCF-7 breast cancer cells. Asian Pac J Cancer Prev 2015; 16: 5507-13.
58. Foo JB, Yazan LS, Tor YS, Armania N, Ismail N, Imam MU and Ismail M: Induction of cell cycle arrest and apoptosis in caspase-3 deficient MCF-7 cells by *Dillenia suffruticosa* root extract *via* multiple signalling pathways. BMC Comple and Altee Med 2014; 14: 1.
59. Tor YS, Yazan LS, Foo JB, Armania N, Cheah YK, Abdullah R and Ismail, M: Induction of apoptosis through oxidative stress-related pathways in MCF-7, human breast cancer cells, by ethyl acetate extract of *Dillenia suffruticosa*. BMC Complementary and Alternative Medicine 2014; 14: 1.
60. Aumsuwan P, Khan SI, Khan IA, Avula B, Walker LA, Helferich WG and Dasmahapatra AK: Evaluation of wild yam (*Dioscorea villosa*) root extract as a potential epigenetic agent in breast cancer cells. *In-vitro* Cellular & Developmental Biology-Animal 2015; 51: 59-71.
61. Ghate, N. B, Das, A, Chaudhuri, D, Panja, S, & Mandal, N. (2016). Sundew plant, a potential source of anti-inflammatory agents, selectively induces G2/M arrest and apoptosis in MCF-7 cells through upregulation of p53 and Bax/Bcl-2 ratio. Cell Death Discovery. 2-15062.
62. Landa P, Skalova L, Bousova I, Langhansova ZK, Lou JD and Vanek T: *In-vitro* anti-proliferative and anti-inflammatory activity of leaf and fruit extracts from *Vaccinium bracteatum* Thunb. Pakistan J Pharm Sci 2014; 27: 103-6.
63. Santos KPD, Motta LB, Santos DY, Salatino, ML, Salatino A, Ferreira MJP and Furlan CM: Antiproliferative activity of flavonoids from *Croton sphaerogynus* Baill. (Euphorbiaceae). BioMed Research International 2015; 212809.
64. Tchoukouegno-Ngueu S, Tchoumtchoua J, Njamen D, Halabalaki M, Laudenbach-Leschowski U and Diel P: *Erythrina excelsa* exhibits estrogenic effects *in-vivo* and *in-vitro* and is cytotoxic on breast and colon cancer cell lines. Pharmaceutical biology 2016; 54: 835-44.
65. Sowemimo A, Venables L, Odedeji M, Koekemoer T, van de Venter M and Hongbing, L: Antiproliferative mechanism of the methanolic extract of *Enterolobium cyclocarpum* (Jacq.) Griseb.(Fabaceae). Journal of Ethnopharmacology 2015; 159: 257-61.
66. Mathi P, Nikhil K, Ambatipudi N, Roy P, Bokka VR and Botlagunta M: *In-vitro* and *in-silico* characterization of *Sophora interrupta* plant extract as an anticancer activity. Bioinformation 2014; 10: 144-51.
67. Al-Massarani S and El Dib R: *In-vitro* evaluation of cytotoxic and antimicrobial potentials of the Saudi traditional plant *Alhagi graecorum* boiss. Pak J Pharm Sci 2015; 28: 1079-86.
68. Yadav NK, Saini KS, Hossain Z, Omer A, Sharma C, Gayen JR and Singh RK: *Saraca indica* bark extract shows *in-vitro* antioxidant, antibreast cancer activity and does not exhibit toxicological effects. Oxidative medicine and cellular longevity 2015; 205360. doi: 10.1155/2015/ 205360.
69. Silva MJD, Carvalho AJS, Rocha CQ, Vilegas W, Silva MA and Gouvêa CMCP: Ethanolic extract of *Mimosa*

caesalpiniifolia leaves: Chemical characterization and cytotoxic effect on human breast cancer MCF-7 cell line. South African Journal of Botany 2014; 93: 64-69.
70. Pereira A, Bester M, Soundy P and Apostolides Z: Anti-proliferative properties of commercial *Pelargonium sidoides* tincture, with cell-cycle G0/G1 arrest and apoptosis in Jurkat leukaemia cells. Pharmaceutical biology 2016; 54: 1831-40.
71. Sarimahmut M, Balikci N, Celikler S, Ari F, Ulukaya E, Guleryuz G and Ozel MZ: Evaluation of the genotoxic and apoptotic potential of *Hypericum adenotrichum* Spach. *In-vitro*. Regulatory Toxicology and Pharmacology 206; 74: 137-46.
72. Engel N, Ali I, Adamus A, Frank M, Dad A, Ali S and Ahmad VU: Antitumor evaluation of two selected Pakistani plant extracts on human bone and breast cancer cell lines. BMC Comple and Alter Med 2016; 16: 244.
73. Tarhan L, Nakipoğlu M, Kavakcıoğlu B, Tongul B and Nalbantsoy A: The Induction of Growth Inhibition and Apoptosis in HeLa and MCF-7 cells by T*eucrium sandrasicum*, Having Effective Antioxidant Properties. Applied biochemistry and biotechnology 2016; 178: 1028-41.
74. Ali MA, Farah MA, Al-Hemaid FM, Abou-Tarboush FM, Al-Anazi KM, Wabaidur SM and Lee J: Assessment of biological activity and UPLC–MS based chromatographic profiling of ethanolic extract of *Ochradenus arabicus*. Saudi journal of biological sciences 2016; 23: 229-236.
75. Husein AI, Ali-Shtayeh MS, Jondi WJ, Zatar NAA, Abu-Reidah IM and Jamous RM: *In-vitro* antioxidant and antitumor activities of six selected plants used in the Traditional Arabic Palestinian herbal medicine. Pharmaceutical Biology 2014; 52: 1249-55.
76. Tayarani-Najaran Z, Amiri A, Karimi G, Emami SA, Asili J and Mousavi SH: Comparative studies of cytotoxic and apoptotic properties of different extracts and the essential oil of *Lavandula angustifolia* on malignant and normal cells. Nutrition and cancer 2014; 66: 424-34.
77. Jassbi AR, Miri R, Roslenadollahi AM, Javanmardi N and Firuzi O: Cytotoxic, antioxidant and antimicrobial effects of nine species of woundwort (Stachys) plants. Pharmaceutical Biology 2014; 52: 62-67.
78. Carocho M, Barros L, Calhelha RC, Ćirić A, Soković M, Santos-Buelga C and Ferreira IC: *Melissa officinalis* L. decoctions as functional beverages: a bioactive approach and chemical characterization. Food & function 2015; 6: 2240-48.
79. Emami SA, Asili J, Hossein NS, Yazdian-Robati R, Sahranavard M and Tayarani-Najaran Z: Growth inhibition and apoptosis induction of essential oils and extracts of Nepeta cataria L. on human prostatic and breast cancer cell lines. Asian Pacific Journal of Cancer Prevention: APJCP 2015; 17: 125-30.
80. Golshan A, Amini E, Emami SA, Asili J, Jalali Z, Sabouri-Rad S and Tayarani-Najaran Z: Cytotoxic evaluation of different fractions of *Salvia chorassanica* Bunge on MCF-7 and DU 145 cell lines. Research in pharmaceutical sciences 2016; 11: 73-80.
81. Rad SK, Kanthimathi MS, Malek SNA, Lee GS, Looi CY and Wong WF: *Cinnamomum cassia* Suppresses Caspase-9 through Stimulation of AKT1 in MCF-7 Cells but Not in MDA-MB-231 Cells. PloS one 2015; 10: e0145216.
82. Amran N, Rani ANA, Mahmud R and Yin KB: Antioxidant and cytotoxic effect of *Barringtonia racemosa* and *Hibiscus sabdariffa* fruit extracts in MCF-7 human breast cancer cell line. Pharmacognosy Research 2016; 8: 66-70.
83. Fawzy GA, Al-Taweel AM and Perveen, S: Anticancer activity of flavane gallates isolated from *Plicosepalus curviflorus*. Pharmacognosy magazine 2014; 10: S519.
84. Sodde VK, Lobo R, Kumar N, Maheshwari R and Shreedhara CS: Cytotoxic activity of *Macrosolen parasiticus* (L.) Danser on the growth of breast cancer cell line (MCF-7). Pharmacognosy magazine 2015; 11: S156-S160.
85. Baharum Z, Akim AM, Taufiq-Yap YH, Hamid RA and Kasran R: *In-vitro* antioxidant and antiproliferative activities of methanolic plant part extracts of *Theobroma cacao*. Molecules 2014; 19: 18317-31.
86. Mamadalieva NZ, Sharopov F, Girault JP, Wink M and Lafont R: Phytochemical analysis and bioactivity of the aerial parts of *Abutilon theophrasti* (Malvaceae), a medicinal weed. Natural Product Research 2014; 28: 1777-79.
87. Kumar R, Kumar N, Ramalingayya GV, Setty MM and Pai KSR: Evaluation of *Ceiba pentandra* (L.) Gaertner bark extracts for *in-vitro* cytotoxicity on cancer cells and *in-vivo* antitumor activity in solid and liquid tumor models. Cytotechnology 2016; 68: 1909-23.
88. Roslen NA, Alewi NAM, Ahamada H and Rasad MSBA: Cytotoxicity screening of *Melastoma malabathricum* extracts on human breast cancer cell lines *in-vitro*. Asian Pacific Journal of Tropical Biomedicine 2014; 4(7): 545-48.
89. El-Sakhawy F, Kassem H, Abou-Hussein D, El-Gayed S, Mostafa M and Ahmed R: Phytochemical investigation of the bioactive extracts of the leaves of *Ficus cyathistipula* Warb. Zeitschrift für Naturforschung C 2016; 71: 141-54.
90. Elsayed EA, Sharaf-Eldin MA and Wadaan M: *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 Pac J Cancer Prev 2015; 16: 4671-75.
91. Liu H, Schmitz JC, Wei J, Cao S, Beumer JH, Strychor S and Zhao X: Clove extract inhibits tumor growth and promotes cell cycle arrest and apoptosis. Oncology Research Featuring Preclinical and Clinical Cancer Therapeutics 2014; 21: 247-59.
92. Zhang L, Shamaladevi N, Jayaprakasha GK, Patil BS and Lokeshwar BL: Polyphenol-rich extract of *Pimenta dioica* berries (Allspice) kills breast cancer cells by autophagy and delays growth of triple negative breast cancer in athymic mice. Oncotarget 2015; 6: 16379-95.
93. Kumar S and Kashyap P: Antiproliferative activity and nitric oxide production of a methanolic extract of *Fraxinus micrantha* on Michigan Cancer Foundation-7 mammalian breast carcinoma cell line. Journal of Intercultural Ethnopharmacology 2015; 4: 109-13.
94. Deljanin M, Nikolic M, Baskic D, Todorovic D, Djurdjevic P, Zaric M and Popovic, S: *Chelidonium majus* crude extract inhibits migration and induces cell cycle arrest and apoptosis in tumor cell lines. Journal of Ethnopharmacology 2016; 190: 362-71.
95. Tabrizi FHA, Irian S, Amanzadeh A, Heidarnejad F, Gudarzi H and Salimi M: Anti-proliferative activity of *Fumaria vaillantii* extracts on different cancer cell lines. Research in Pharmaceutical Sciences 2016; 11: 152-59.
96. Mendis AS, Thabrew I, Samarakoon SR and Tennekoon KH: Modulation of expression of heat shock proteins and apoptosis by *Flueggea leucopyrus* (Willd) decoction in three breast cancer phenotypes. BMC complementary and alternative medicine 2015; 15: 404-17.

97. Graidist P, Martla M and Sukpondma Y: Cytotoxic activity of *Piper cubeba* extract in breast cancer cell lines. Nutrients 2015; 7: 2707-18.
98. de Souza Grinevicius VMA, Kviecinski MR, Mota NSRS, Ourique F, Castro LSEP.W, Andreguetti RR and Pedrosa RC: *Piper nigrum* ethanolic extract rich in piperamides causes ROS overproduction, oxidative damage in DNA leading to cell cycle arrest and apoptosis in cancer cells. Journal of Ethnopharmacology 2016; 189: 139-47.
99. Halabi MF and Sheikh BY: Anti-proliferative effect and phytochemical analysis of *Cymbopogon citratus* extract. BioMed Research International 2014; 906239. doi: 10.1155/2014/906239.
100. Aboul-Enein AM, Shanab SM, Shalaby EA, Zahran MM, Lightfoot DA and El-Shemy HA: Cytotoxic and antioxidant properties of active principals isolated from water hyacinth against four cancer cells lines. BMC complementary and alternative medicine 2014; 14: 1-11.
101. Shirode AB, Kovvuru P, Chittur SV, Henning SM, Heber D and Reliene R: Antiproliferative effects of pomegranate extract in MCF-7 breast cancer cells are associated with reduced DNA repair gene expression and induction of double strand breaks. Molecular Carcinogenesis 2014; 53: 458-70.
102. Farmani F, Moein M, Amanzadeh A, Kandelous HM, Ehsanpour Z and Salimi M: Antiproliferative evaluation and apoptosis induction in MCF-7 cells by *Ziziphus spina* christi leaf extracts. Asian Pacific Journal of Cancer Prevention 2016; 17: 315-21.
103. Atmaca H, Bozkurt E, Cittan M and Tepe HD: Effects of *Galium aparine* extract on the cell viability, cell cycle and cell death in breast cancer cell lines. Journal of Ethnopharmacology 2016; 186: 305-10.
104. Shoja MH, Reddy ND, Nayak PG, Srinivasan KK and Rao CM: *Glycosmis pentaphylla* (Retz.) DC arrests cell cycle and induces apoptosis *via* caspase-3/7 activation in breast cancer cells. Journal of Ethnopharmacology 2015; 168: 50-60.
105. Felipe KB, Kviecinski MR, da Silva FO, Bücker NF, Farias MS, Castro LSEPW, and Pedrosa RC: Inhibition of tumor proliferation associated with cell cycle arrest caused by extract and fraction from *Casearia sylvestris* (Salicaceae). Journal of Ethnopharmacology 2014; 155: 1492-99.
106. Kim HA, Kim MS, Kim SH and Kim YK: Pepper seed extract suppresses invasion and migration of human breast cancer cells. Nutrition and Cancer 2014; 66: 159-65.
107. Lay MM, Karsani SA, Banisalam B, Mohajer S and AbdMalek SN: Antioxidants, phytochemicals, and cytotoxicity studies on *Phaleria macrocarpa* (Scheff.) Boerl seeds. BioMed Research International 2014; 906239. doi: 10.1155/2014/906239.
108. Han EB, Chang BY, Jung YS and Kim SY: *Lantana camara* induces apoptosis by Bcl-2 Family and caspases activation. Pathology & Oncology Research 2015; 21: 325-31.
109. Ahmed Hamdi OA, Syed Abdul Rahman SN, Awang K Abdul Wahab N, Looi CY, Thomas NF and Abd Malek SN: Cytotoxic constituents from the rhizomes of *Curcuma zedoaria*. The Scientific World Journal 2014; 321943. doi: 10.1155/2014/321943.
110. Ghasemzadeh A, Jaafar HZ, Rahmat A and Ashkani S: Secondary metabolites constituents and antioxidant, anticancer and antibacterial activities of *Etlingera elatior* (Jack) RM Sm grown in different locations of Malaysia. BMC Comple and Alter Med 2015; 15: 1.
111. Samarghandian S, Afshari JT and Hosseini M: Antiproliferative activity and induction of apoptotic by ethanolic extract of *Alpinia galanga* rhizhome in human breast carcinoma cell line. BMC complementary and alternative medicine 2014; 14: 1.
112. Xu GL, Geng D, Xie M, Teng KY, Tian YX, Liu ZZ and Yang Y: Chemical composition, antioxidative and anticancer activities of the essential oil: Curcumae rhizoma–sparganii rhizoma, a traditional herb pair. Molecules 2015; 20: 15781-96.

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