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Yemeni Medicinal Plants as A Source of Anticancer Drugs: A Review

Helmi Ahmed Qassm Mokbel[1,3], Seham Salah El Dine El Hawary[1], Rasha Mosa Allam[2], Amira Kamal El-din El-Motayam[1], Ali Mahmoud El Halawany[1*]

[1]*Department of Pharmacognosy, Faculty of Pharmacy, Cairo University, Cairo 11562, Egypt*

[2]*Pharmacology Department, Medical and Clinical Research Institute, National Research Centre, Dokki, Cairo, 12622, Egypt*

[3]*Ministry of Higher education and scientific research,* Yemen

Abstract

Cancer is the leading cause of death worldwide and a serious metabolic illness. Finding novel compounds that are optimally harmful to cancer cells but not to healthy ones has become crucially important. Plant-based medications continue to be an important source for the treatment of severe ailments, especially in developing countries. Traditional medicine has a long history and is still widely used in Yemen to treat a wide range of illnesses. Flora of Yemen is rich in endemic and semi-endemic plants, constituting about 16% of Yemeni plants which recorded 2838 plant species belonging to 179 families. Therefore, the present review aims to summarize the cytotoxic plants available in Yemen. The review covers 229 species, belonging to 163 genera and 72 families collected from several localities in Yemen.Most of studies showed high and intermediate activity against 44 different cancer cell lines such as liver, and breast using different assays and different extraction solvents as well as over 7 isolated bioactive cytotoxic compounds. Current study concluded that Yemeni medicinal plants are considered as an underutilized source of medicines for treating cancer. Further great efforts are required to evaluate the effectiveness of different Yemeni plants on several cancer cell lines, to isolate and identify the chemical compounds responsible for such activity.

***Keywords*:** Cytotoxicity, Yemen flora, Medicinal Plants, Review, Cancer Cell Lines, Phytoconstituents

1. Introduction

Cancer is the primary cause of death globally and a serious metabolic disorder. According to statistics, cancer kills one sixth of the people worldwide, and low- and middle-class individuals account for 70% of these deaths[1]. It involves the unchecked growth of normal cells due to genetic abnormalities and instability, which leads to the production of cancerous cells and the start of tissue invasion or metastasis. Both internal and environmental influences, including exposure to radiation and pesticides, smoking tobacco, ingesting carcinogenic chemicals or metals and changes in hormonal balance and immune system can result in these alterations. A number of other factors, including gender, age, race, genetic predisposition, and exposure to environmental carcinogens such as gasoline, aflatoxins, azo dyes, and mutagenic agents are also linked to the incidence and geographic distribution of cancer[2].

The issue of rising cancer rates globally has prompted a greater effort to find novel substances that are ideally poisonous to cancer cells but not to healthy ones. Given that the chemotherapeutic drugs now in use are relatively toxic to both normal and cancerous cells[1]. Natural medicines have been the cornerstone of traditional medicine for decades in many cultures, and today's medicinal plants have a dominant role in the production of novel pharmacologically active compounds[3]. Plants have long been known to have anticancer effects. Finding novel naturally occurring chemicals with targeted action against various cancer types is of incredible interest. Approximately 60% of the medications used to treat cancer today were first derived from natural sources, with plants being the main source.

Numerous and diverse plants are recognized to possess therapeutic qualities. From algae to trees, an estimated 70,000 plant species have been utilized medicinally. About 35,000 plant species have been investigated by the National Cancer Institute (NCI) for possible anticancer properties. Roughly 3000 plant species exhibited consistent anticancer activity among them[1]. Only around 140 anticancer medications have been approved for the treatment of over 200 cancer types, for the majority of cancers, there are no effective treatments[2].

Although these plants' bioactive components can be conventionally extracted from a variety of natural sources, they can also be generated more effectively utilizing a variety of biotechnological methods. Chemically speaking, a wide variety of secondary metabolites have been shown to have anticancer effects; the most common classes are alkaloids, terpenoids, and polyphenols[1].

In addition to chemotherapy, other cancer treatment modalities include immunotherapy, hormone therapy, radiotherapy, and surgery. All of these tactics, however, come with serious side effects, including harm to healthy body cells, interference

*Corresponding author e-mail: ali.elhalawany@pharma.cu.edu.eg; (**Ali Mahmoud El Halawany**).
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with normal metabolic processes, changes to the immune system or hormone balance, etc. Chemotherapy is frequently the only treatment option for metastatic cancer [4]. Thus, it is necessary to look for safe and effective substitute medications and/or therapy modalities for cancer. Isolating novel components from natural products is critical even with the introduction of current drug discovery technologies like computer-aided drug design and combinatorial chemistry[2]. This is due to the fact that plants' secondary metabolites naturally change in response to various environmental factors, indicating that complex natural combinatorial chemistry is constantly occurring in plants. A surprising variety and number of natural products may exist as a result of the evolution of secondary metabolism in plants, which has generated secondary metabolites based on the needs of the plants [5].

According to earlier researches, cytotoxic phytochemicals can cause necrosis and apoptosis or block a range of cell-signaling pathways, which can result in cell death or cell cycle arrest. Tumor cells exhibit multiple molecular mechanisms that mitigate apoptosis, and this suppression of apoptosis is a critical factor in the advancement of cancer. Therefore, a novel treatment strategy for cancer chemotherapy may involve the stimulation of apoptosis or necrosis by cytotoxic chemicals. It is essential to search the variety of natural plant resources for novel and updated cytotoxic compounds, since the majority of antineoplastic medications have a direct or indirect (semi-synthetic) origin in plants and are cytotoxic phytochemicals[2].

Drugs derived from plants are still a valuable resource for treating serious illnesses, particularly in developing nations. The majority of people on the planet still treat common ailments using traditional medicines, about 60–80% of them. In many parts of Yemen, traditional medicine has a long history and is still a valuable tool for treating many conditions[6]. Herbal medicine has a long history of being used in Yemen to treat a wide range of illnesses, including infections, inflammations, and other conditions [7]. These plants were used as herbal formulations in crude forms like tinctures, teas, powders, and poultices. The traditional way by which these plants were used can still be found in communities, passed down through natural history, and still prevail to be a successful form of medication, despite the advent of modern medicine[8].

Effective anticancer medicines have been derived from plants for a long time; nowadays, over 60% of anticancer medications are derived from natural sources, such as plants, marine organisms, and microorganisms, or are connected to them. These include naturally occurring taxanes such as paclitaxel, which was isolated from *Taxus baccata* and *Taxus brevifolia*; etoposide and teniposide; the semi-synthetic derivatives of epipodophyllotoxin, which were isolated from Podophyllum species; the Vinca alkaloids, such as vinblastine and vincristine, which were isolated from Catharanthus roseus; and a number of other naturally occurring taxanes. As a result, there is now more interest in using traditional medicine to cure or prevent tumors [9].

Yemen Situated in the southwest region of the Arabian Peninsula, it is situated between latitudes 12°40′ and 19°00′ N and longitudes 42°30′ and 53°05′ E. Yemen is characterized by rough highlands and mountains with multiple peaks rising beyond 3000 meters (10,000 feet), in contrast to the Arabian Peninsula, which is noted for its enormous, hostile deserts. Yemen has long coastline, which stretches 1906 km (1184 miles), borders the Red Sea and the Gulf of Aden to the east and south. Additionally, Yemen contains more than a hundred little islands dispersed around the Arabian and Red Seas. Yemen's overall area, including the islands, is 527,970 sq km (203,850 sq mi). The Yemeni highlands have a moderate climate and receive a fair amount of rainfall. Yemen has a great topographic diversity due to its coastal lowlands, eastern plateau, and deserts. This, together with climatic conditions, has produced a rich and varied flora[8]. According to **Al Khulaidi** (2013) [10], Flora of Yemen book; the plant life in Yemen is rich, his study recorded 2838 plant species belonging to 1068 genera and 179 families, The vegetation in Yemen is rich in endemic and semi-endemic plants, estimated at about 608 plants, of which 457 are endemic, meaning their presence is limited to Yemen only (307 are found in Socotra) and constitutes about 16% of Yemeni plants[10].

The country's climate is primarily influenced by two factors. Yemen's winters are dominated by dry northerly winds, while the spring and summer months are characterized by moist monsoons. The highlands experience a temperate climate with mild, dry winters and warm summers with plenty of rainfall, making height another important element influencing the climate. For instance, the average temperature of Sana'a, a region in the central highlands, is 14 °C in January and 22 °C in July. While the highlands of Ibb and Taiz receive more over 1000 mm (40 in) of rain annually, Sana'a receives only 265 mm (10.4 in) on average[8].

Yemen's largest and capital city is Sana'a. The city is situated at an elevation of around 2200 meters, spanning a highly productive basin close to the base of the Jabal Nuqum mountain. Taiz is located in the lush highlands at an elevation of 1400 meters. Coffee (Coffea arabica) and khat (Catha edulis), which are mild stimulants, are the principal crops in this prosperous agricultural area. Ibb is situated at an elevation of 2050 meters, north of Taiz, in the southern highlands. Because of the rich volcanic soil and plentiful rainfall, the area is verdant and fertile for agriculture, with wheat, coffee, khat, fruits, and vegetables being the main crops grown there[8].

The island of Soqotra in Yemen has long been a land of mystery and is considered the “jewel” of biodiversity in the Arabian Sea. The long geological isolation and its fierce heat and many droughts have combined to create a unique and spectacular endemic flora. More than 800 plant species estimated to belonging to more than 100 plant families occur of which 308 species are considered to be endemic[11].

Therefore, the current study was carried out in an effort to review Yemeni cytotoxic plants and active biomolecules that could assist innovative and alternative cancer chemotherapy treatment approaches.

2. Methodology

2.1. Search Strategy

A thorough search of the literature was conducted utilizing a number of resources, including ScienceDirect, PubMed, Google, and Google Scholar. "Anticancer", "antitumor", "cytotoxic", "plants", and "Yemeni medicinal plant" were the search terms that were employed. The review also contained any relevant information regarding cytotoxicity studies on medicinal plants collected from any location in Yemen[2].

2.2. Selection of Studies for Inclusion in the Review

The focus of this review was on previous studies conducted evaluation of cytotoxicity of medicinal plants collected from Yemen up to January 2024[2].

2.3. Data Extraction

The studies were reviewed with respect to the following information: families, botanical name, the local name, locality of collection (occurrence), plant part used, traditional uses, type of solvent or bioactive compounds, their respective IC_{50} values (concentration required to inhibit 50% population), type of cell line and type of assay.

Cytotoxic Plants of Yemen

This review focused on cytotoxic potential and bioactive compounds obtained from the plants in Yemen. A total of 229 medicinal plants from 72 families were reviewed for cytotoxicity studies and were listed in **Table (1)**.

3. Results

A total of (1083) IC_{50} results were obtained from fifty-two reports[6, 7, 9, 11-59], associated to the cytotoxic potential of 229 Yemeni medicinal plants, and were retrieved from the databases selected. All previous studies till July 2024, related to the cytotoxicity of the crude extracts from plants collected in Yemen towards different human carcinoma cell lines, were presented in **Table (1)**. Most of the plants came from Governorates of (Abyan, Aden, Al Mahweet, Aldha'la, Al-Mahra, Amran, d.l.Y, Dhamar, Hadhramaut, Hajjah, Hodeidah Ibb, Lahaj, Sada`a, Sana'a, Shabwah, Tehama, and Taiz). Soqotra and Rada'a were also included in the studies illustrated in **Table (1).**

In comparison with data of book "Flora on Yemen" total plant species is about 2838 species, belonging to 1068 genera and 179 families, (2602 naturalized, 129 cultivated and 107 introduced).Our findings included about 229 species, belonging to 163 genera and 72 families showed in **table (2),** which means mainly around 9 % of Yemeni plant species and 15% of genera and 40 % of families were screened for different cytotoxicity studies.The most studied species were *Dictyota dichotoma, Aloe perryi, Acalypha fruticose, Peperomia blanda, Pulicaria jaubertii (P. orientalis), Jatropha variegate, Curcuma Longa, Dracaena cinnabari, Vernonia leopoldii, Limonium socotranum* and *Croton socatranus* are illustrated in **figure (1)**.

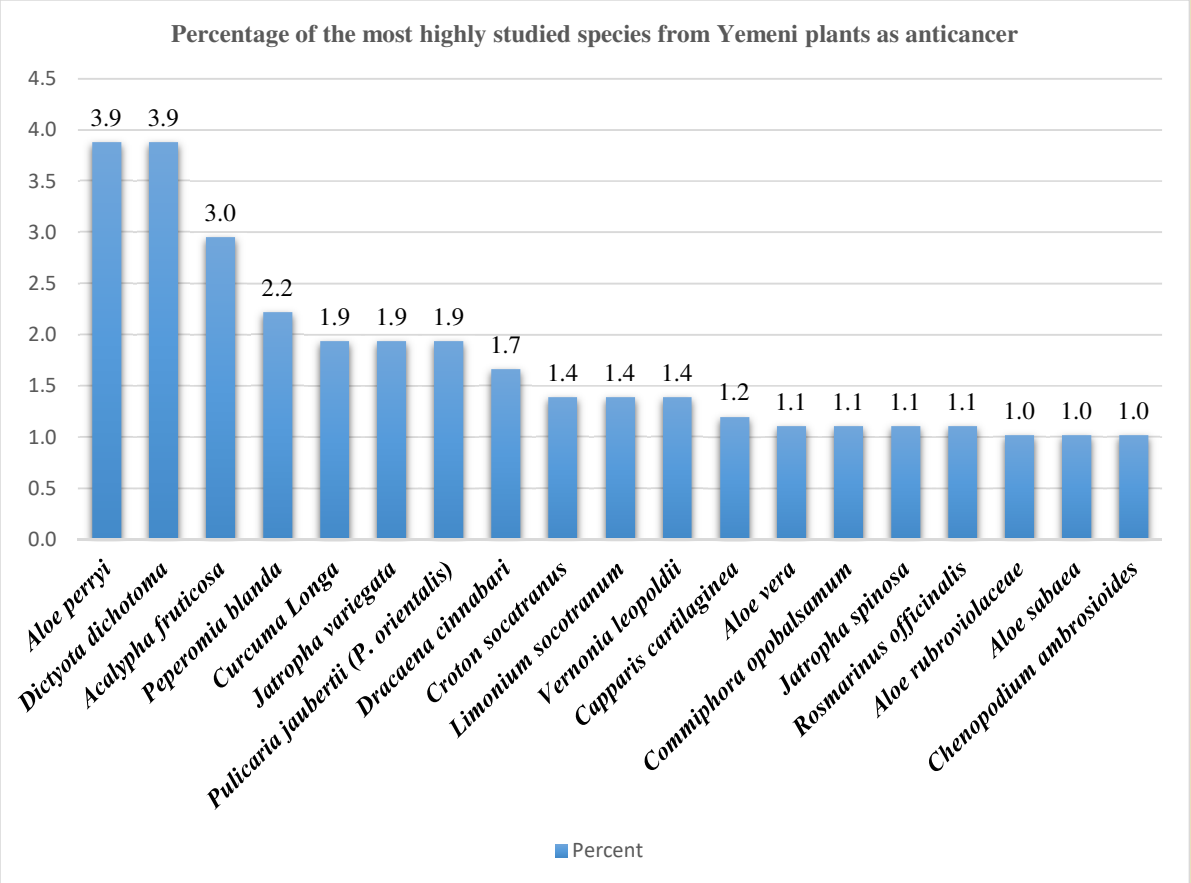

Figure 1: Diagram of the most highly studied species from Yemeni plants as anticancer

The National Cancer Institute and Geran protocol's criteria stated that extracts with an IC_{50} less than 20µg/mL are extremely cytotoxic, those with an IC_{50} of 21–200 µg/mL are moderately cytotoxic, while those with an IC_{50} of 201–500 µg/mL are weakly cytotoxic, and those with an IC_{50}> 501 µg/mL are not cytotoxic[60]. So, we categorized the 1083 findings as follows: 313 results with IC_{50} less than 20 µg/mL which are extremely cytotoxic, 491 results with IC_{50} of 21–200 µg/mL are moderately cytotoxic, 96 results with an IC_{50} of 201–500 µg/mL (weakly cytotoxic), 139 results with an IC_{50} > 501 µg/mL (not cytotoxic), and 43 results with unknown or not determined activity, illustrated in diagram form in **figure (2)**.

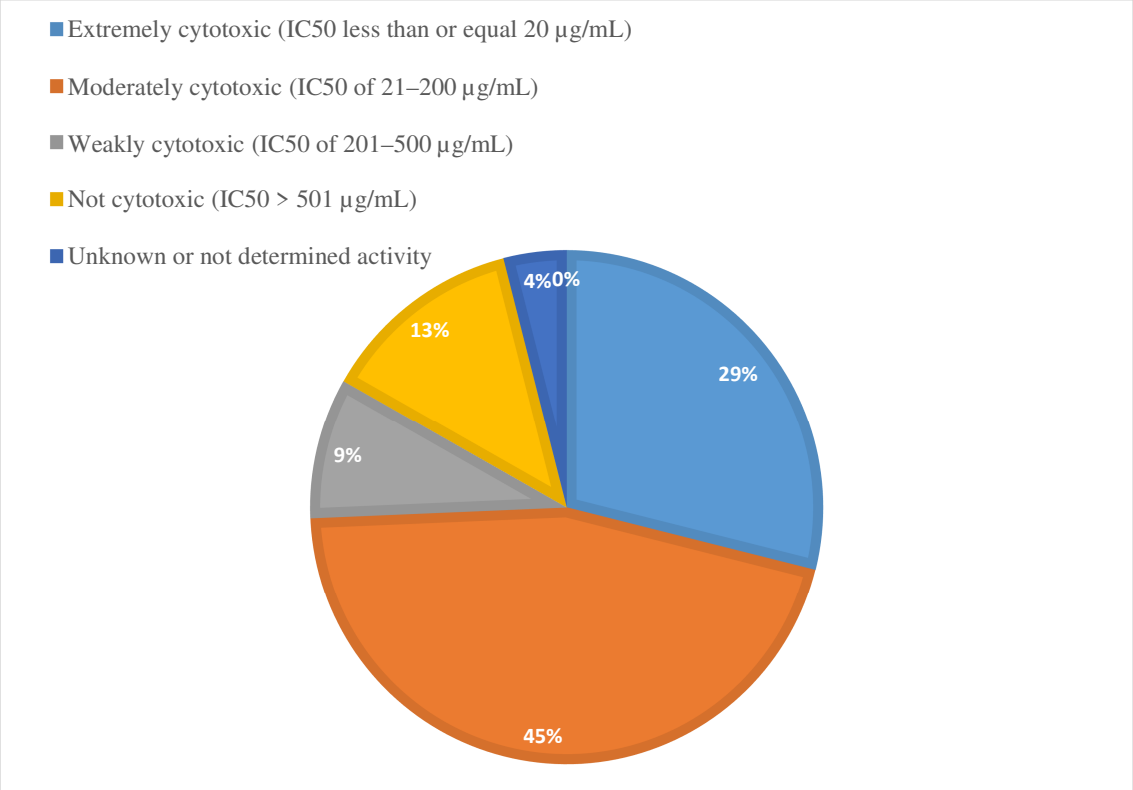

Figure 2: Diagram of cytotoxic potency of plants from Yemen classified according toThe National Cancer Institute and Geran protocol's criteria

Focusing on extremely cytotoxic plantsthat representing 29% of our search findings; the most activity was seen with essential oils of *Tagetes minuta, Lantana camara, Eucalyptus camaldulensis, Conyza incana, Thymus laevigatus, Schinus molle, Artemisia abrotanum, Chenopodium ambrosioides, Mentha piperita, Rosmarinus officinalis, Coriandrum sativum, Ocimum basilicum, Origanum majorana, Pulicaria jaubertii (P. orientalis)* with IC_{50} ranging from 0.003-0.21 µg/mL. Also, methanolic, ethanolic, dichloromethane, and chloroform extracts and other organic solvents fractions and some isolated compounds of 51 medicinal plants showed high activity with IC_{50} ranging from 0.24-20.9 µg/mL. *Gomphocarpus fruticosus, Kanahia laniflora* and *Vernonia leopoldii* are among these highly active plants.

Forty-four different cancer cell lines were included in our findings mentioned at the end of the **Table (1)**. Most potent activity were reported from specified plants on Thirty-five cancer cell lines, mostly on **MCF-7** (breast cancer), **HepG-2** (Hepatocellular carcinoma), **A-427** (lung cancer), **5637** (urinary bladder cancer), **HELa** (cervical cancer), and **A-549** (lung adenocarcinoma).

Only seven isolated compounds were found in this review illustrated in **figure (3)**, three compounds (1α-methoxy, 8α-methacryloyloxy-hirsutinolide-13-O-acetate, 8α-methacryloyloxy-hirsutinolide-13-O-acetate, and lanost-3β, 23S-dihydroxy-22(31)-ene) isolated from aerial parts of *V. leopoldii* collected from Ibb, **two** compounds (2-methoxyfuranodiene and 2-acetoxyfuranodiene) isolated from Oleo-gum-resin of *Commiphora myrrh* purchased from Sana`a, and (2,4'-dihydroxy-4-methoxydihydrochalcone and 2,4'-dihydroxy-4-methoxyhydrochalcone) isolated from resin of Soqotrian Dam alakhwain (*Dracaena cinnabari*) **[**39**,** 48**,** 53**].**

Table (1) In *vitro* cytotoxicity of extracts and isolated compounds from medicinal plants collected from different localities in Yemen against different cancer cell lines

Family	Medicinal Plant	Local name	Occurrence	Part used for study	Extract used for study/ isolated compound	Cancer Cell line Type	IC50 in µg/mL	Type of Assay	Traditional Uses	Ref.
Acanthaceae	***Anisotes trisulcus* (Forsk.)**	**Madid**	**Sana'a**	**Leaves**	**Ethanol**	**FL**	**155**	**NRU**	**Jaundice**	[32]
	***Ballochia atrovirgata*Balf.f**	**Mosis**	**Soqotra**	**Leaves, Stem**	**Methanol**	**5637**	**2.83**	**MP**	**Unknown**	[55]
						A-427	**1.58**			
						MCF-7	**2.94**			
						MRC-5	**2.1**	**nd**		[11]
	***Barleria trispinosa*(Forssk.) Vahl**	**Shakhth**	**d.l.Y**	**Leaves, Stem**	**Methanol**	**5637**	**>50**	**MP**	**For warts epically on the face**	[9]
						A-427	**>50**			
						MCF-7	**>50**			
			Yemen and Saudi Arabia			**MRC-5**	**>64**	**nd**		[52]
	***Blepharis ciliaris*(L.) B.L.Burtt.**	**Zughf**	**d.l.Y**	**Leaves**	**Methanol**	**5637**	**>50**	**MP**	**For wounds and skin diseases**	[9]
						A-427	**>50**			
						MCF-7	**>50**			
	***Blepharis spiculifolia*Balf.f**	**Mlishitt**	**Soqotra**	**Leaves, Stem**	**Methanol**	**5637**	**>50**	**MP**	**Unknown**	[55]
						A-427	**>50**			
						MCF-7	**>50**			
	***Hypoestes forskalei*(Vahl) R. Br.**	**Sawrub**	**d.l.Y**	**Leaves**	**Methanol**	**5637**	**14.3**	**NRU**	**Fungal skin diseases, scabies and itching**	[7]
					Aqueous	**5637**	**>500**			
					Aqueous	**MCF-7**	**>500**			
					Methanol	**MCF-7**	**32.1**			
			Yemen and Saudi Arabia		**Methanol**	**MRC-5**	**11**	**nd**		[52]
	***Hypoestes pubescens*Balf.f**	**nd**	**Soqotra**	**Leaves**	**Methanol**	**5637**	**8.25**	**MP**	**Fungal skin diseases and scabies**	[55]
						A-427	**4.85**			
						MCF-7	**7.03**			
						MRC-5	**32.7**	**nd**		[11]
Amaranthaceae	***Aerva javanica*(Burm. fil.) Juss.**	**Ra**	**Dhamar**	**Fruit**	**Methanol**	**FL**	**780**	**NRU**	**Sedative**	[18]
	***Amaranthus polygamus* L.**	**nd**	**Yemen and Saudi Arabi**	**Leaves**	**Methanol**	**MRC-5**	**>64**	**nd**	**Anthelmintic, cancer, and**	[52]

			a						impotence	
	Amaranthus viridis L.	nd	d.l.Y	Leaves	Methanol	5637	>250	NRU	Breast tumors, impotence and anthelmintic	[7]
					Aqueous		>500			
					Aqueous	MCF-7	>500			
					Methanol		>250			
Anacardiaceae	*Lannea transulta*(Balf.f.) Radcl.-Sm.	Kinhar	Soqotra	Leaves	Methanol	5637	>50	MP	Haemostatic for wounds, and sores and abrasions	[55]
						A-427	>50			
						MCF-7	>50			
	*Rhus retinorrhaea*Steud. ex Oliv.	Talb	d.l.Y	Leaves	Methanol	5637	>50	MP	General tonic and for painful joints	[9]
						A-427	>50			
						MCF-7	>50			
	*Rhus thyrsiflora*Balf.f.	Zorf	Soqotra	Leaves, Fruit	Methanol	5637	>50	MP	To treat anorexia, general tonic and for painful joints	[55]
						A-427	>50			
						MCF-7	>50			
						MRC-5	53.2	nd	To treat anorexia, general tonic and for painful joints	[11]
	Schinus mole L.	Filfil kadhib	Sana'a	Fruit	Essential Oil	3T3	0.013	MTT	nd	[27]
						CEMss	0.025			
						CHO	0.022			
						HeLa	0.065			
						MCF-7	0.045			
						MDA-MB 231	0.04			
						WEHI-3B	0.008			
Apiaceae (Umbelliferae)	*Coriandrum sativum* L.	Kazbirah	Sana'a	Seeds	Essential Oil	3T3	0.027	MTT	nd	[27]
						CEMss	0.015			
						CHO	0.06			
						HeLa	0.024			
						MCF-7	0.025			
						MDA-MB 231	0.032			

						WEHI-3B	nd			
Apocynaceae (Asclepiadaceae)	*Calotropis procera*(Ait.)	Ushar	Abyan	Leaves	Ethanol	FL	31	NRU	Antiseptic for skin infection	[32]
	Caralluma penicillate (Deflers) N.E.Br	Ghalaf	d.l.Y	Leaves	Methanol	5637	244	NRU	Diabetes, stomachic ulcer and smallpox	[7]
					Aqueous		>500			
						MCF-7	>500			
					Methanol		>250			
			Taiz	Fruit		FL	>1000		Skin rash, scabies	[18]
			Yemen and Saudi Arabia	Leaves		MRC-5	>64	nd	Diabetes, stomach ulcer, and smallpox	[52]
	Caralluma quadrangular (Forssk.) N.E.Br.	Shardir	d.l.Y	Leaves	Methanol	5637	218	NRU	Diabetes, stomachic ulcer and smallpox	[7]
					Aqueous		>500			
					Aqueous	MCF-7	>500			
					Methanol		>250			
	Caralluma socotrana(Balf.f.)N.E.Br.	Qamhiyn	Soqotra	Aerial parts	Aqueous	FL	348.7	NRU	dyspepsia	[31]
					Chloroform		609.2			
					Methanol		nd			
	*Ceropegia rupicola*Defl.	Bukira	Taiz	Aerial parts	Methanol	A-549	49.4	MTT	Externally administered for skin problems	[44]
						Bj-1	42.5			
						PC-3	34			
	*Glossonema revoili*Franch.	nd	Soqotra	Leaves, Flower	Methanol	5637	>50	MP	Increase milk production in breastfeeding women	[55]
						A-427	>50			
						MCF-7	>50			
	Gomphocarpus fruticosus(L.) Ait. F.	Sobie	d.l.Y	Leaves	Methanol	5637	5.5	MP	For heart diseases	[9]
						A-427	1.2			
						MCF-7	6.2			
			Yemen and Saudi Arabia			MRC-5	2.3	nd	Tumors, skin disease, scabies, and itching	[52]
	Kanahia laniflora(Forsk.) R. Br.	Kanah	d.l.Y	Root	Methanol	5637	1.2	MP	For tumors and skin diseases, scabies and itching	[9]
						A-427	0.5			
						MCF-7	1.3			
	Leptadenia pyrotechn(Forssk.) Decne.	Marh	Schuqura	whole parts	Methanol	FL	550	NRU	Wound	[18]
	Orbea deflersiana(Lavranos) Bruyns.	Urza	Imkhudeera	whole parts	Methanol	FL	>1000	NRU	Diabetes, wound	[18]
	Orbea	Khus	Qaren	whol	Chloroform	HeP	222.	M	eaten for	[56]

	wissmanniiO. Schwart	maa	region, Amra n	e parts	Methanol	G-2	34 228. 97	TT	stomach ulcers, constipati on, food poisoning (antidote), diabetes	
	Pergularia tomentosa L.	Ghalq a	d.l.Y	Leav es, Stem	Methanol Aqueous Methanol	5637 MC F-7	21.5 42.9 >500 >250	N R U	Anthelmi ntic, for tumors, warts and skin diseases	[7]
	Rhytidocaulon tortum(N.E. Br.) M.G. Gilbert	Quar an	Hodei dah	whol e parts	Methanol	FL	980	N R U	Wound, allergy	[18]
Aristoloc hiaceae	*Aristolochia bracteate* Retz	Qard ah	d.l.Y	Leav es, Stem	Methanol Aqueous Methanol	5637 MC F-7	>250 >500 >500 >250	N R U	Antimalar ia, anthelmin tic, urinary tract infections and snake bites	[7]
Asphodel aceae (Aloeacea)	*Aloe niebuhriana*Lav.	Saber	Taiz-Ala`ab oos	leave s latex	nd	HC T-116 HeP G-2 MC F-7	361 526 270. 4	SR B	for the external treatment of eye and skin conditions and for treating all sorts of stomach problems and liver or spleen enlargeme nt	[50]
	*Aloe perryi*Baker	Tayf, Saber Socot ri	Soqotr a	Seed s	Methanol Petroleum ether/ethylac etate (1:1) extrac	ECV -304	>50 >50	M TT	Skin disease	[17]
				Flow er	Aqueous Chloroform Ethyl acetate *n*-butanol Petroleum ether	A-549	22.6 13 18.8 18.8 7.54	C V	wound healing, burns and topical treatment of skin diseases	[26]
					Aqueous Chloroform Ethyl acetate *n*-butanol Petroleum ether	HC T-116	17.5 14.1 19.8 10.3 5.61			
					Aqueous Chloroform Ethyl acetate *n*-butanol Petroleum ether	HeL a	>50 12.1 >50 11.1 5.83			

					Aqueous	HEP - 2	40.1			
					Chloroform		18.7			
					Ethyl acetate		29.1			
					n-butanol		26.7			
					Petroleum ether		10.1			
					Aqueous	HeP G-2	21.5			
					Chloroform		17.3			
					Ethyl acetate		18.5			
					n-butanol		16.9			
					Petroleum ether		8.2			
					Aqueous	MC F-7	27.4			
					Chloroform		22.9			
					Ethyl acetate		>50			
					n-butanol		12.7			
					Petroleum ether		7.88			
					Aqueous	PC-3	29.4			
					Chloroform		21.7			
					Ethyl acetate		>50			
					n-butanol		19.7			
					Petroleum ether		9.51			
				Resin	Ethanol	FL	145	NRU	Eye infection, wound healing	[32]
				Root	Methanol	5637	>50	MP	For eye and stomach problems, constipation and malaria	[55]
						A-427	>50			
						MCF-7	>50			
						MRC-5	>64	nd		[11]
	*Aloe rubroviolacea*Schweinf.	Saber	Taiz-saber	Flower	Ethanol	A-549	26.5	CVS	nd	[24]
						CACO	30.1			
						CHO-K1	>100			
						HCT-116	29.7			
						HeLa	>100			
						HEP - 2	>100			
						HePG-2	55.7			
						MCF-7	89.5			
						MNFS-60	>100			
						PC-3	58.3			
						RD	61.8			
	*Aloe sabaea*Schweinf.	Quba b	Ibb-Miatam and Aldlel	Flower	Ethanol	A-549	43,6	CVS	nd	[24]
						CACO	92			
						CH	>100			

						O-K1				
						HCT-116	51.3			
						HeLa	>500			
						HEP-2	>500			
						HePG-2	>100			
						MCF-7	>100			
						MNFS-60	>100			
						PC-3	>100			
						RD	>100			
	*Aloe vera*L. Burm.f.	Saber	Ibb-Badan	Flower	Ethanol	A-549	12	CVS	nd	[24]
						CACO	14.6			
						CHO-K1	>100			
						HCT-116	14			
						HeLa	>100			
						HEP-2	62.3			
						HePG-2	52.4			
						MCF-7	60.3			
						MNFS-60	>100			
						PC-3	46.1			
						RD	14.7			
			Tahama	Seeds	Methanol	FL	>1000	NRU	Malaria	[18]
Asteraceae (Compositae)	*Acanthospermum hispidum*D.C.	nd	Soqotra	Leaves	Methanol	5637	9.37	MP	Unknown	[55]
						A-427	16.7			
						MCF-7	19.92			
	*Achillea biebersteinii*Afan.	Aldefera	d.l.Y	Leaves	Methanol	5637	>250	NRU	Liver diseases, spasmolytic and analgesic for childbirth	[7]
					Aqueous		>500			
					Methanol	MCF-7	>500			
							>250			
	Achillea fragrantissima (Forssk.) Sch.Bip.	Qaysoom	Dhamar	Leaves	Essential Oil	HCT-116	134.6	MTT	stomachic and anthelmintic and for treating	[47]
						SW480	110.1			

									chronic diseases as arthritis and diabetes	
	Artemisia abrotanum	nd	Thamar	Aerial parts	Essential Oil	3T3	nd	MTT	nd	[27]
						CEMss	0.025			
						CHO	0.0125			
						HeLa	0.042			
						MCF-7	0.062			
						MDA-MB231	0.1			
						WEHI-3B	nd			
	*Artemisia abyssinica*Sch.Bip. ex A. Rich	Boaithran	Sana'a	Aerial parts	Essential Oil	HT-29	75.42	XTT	anthelmintic, antispasmodic, antirheumatic and antibacterial agent	[61]
	*Artemisia arborescens*L.	Rihan	nd	nd	Ethanol	MCF-7	0.39	MTT	dermatitis, allergic reactions, itchiness lymphatic drainage, venous congestions Asthma, hay fever, asthmatic bronchitis.	[29]
			Sana'a	Aerial parts	Essential Oil	HT-29	16.91	XTT	anti-inflammatory remedy	[61]
	Carthamus tinctorius L.	Qurtum	d.l.Y	Leaves, Stem	Hot aqueous	FL	>1000	NRU	Skin diseases e.g. freckles, coloring agent and in food	[6]
					Methanol		100			
	Centaurea pseudosinaica Czerep.	Sanafah	d.l.Y	Leaves, Fruit	Hot aqueous	FL	>1000	NRU	Wounds, kidney diseases	[6]
					Methanol		540			
	Centaurothamus maximus(Forssk.) Wagenitz & Dittrich	Boyadh	d.l.Y	Leaves, Flower	Methanol	5637	9.4	MP	For wounds	[9]
						A-427	11.5			
						MCF-7	9.9			
			Yemen and	Leaves		MRC-5	9.3	nd	Wounds	[52]

			Saudi Arabia							
	Conyza incana(Vahl)Willd.	Biadh	Taiz-Hojariah	Seeds	Essential Oil	3T3	0.05	MTT	nd	[27]
						CE Mss	0.0065			
						CHO	0.09			
						HeLa	no activity			
						MCF-7	no activity			
						MDA-MB 231	no activity			
						WEHI-3B	0.025			
	Dichrocephala integrifolia(L.f.) O. Kuntze	nd	d.l.Y	Leaves, Flower	Methanol	5637	13.9	MP	For wounds	[9]
						A-427	10.4			
						MCF-7	20.8			
			Yemen and Saudi Arabia	Leaves, Stem		MRC-5	24.5	nd	Wounds	[52]
	*Echinops spinosissimus*Turra	Jirdab	d.l.Y	Leaves	Methanol	5637	>250	NRU	Urinary tract infections, fungal and skin diseases	[7]
					Aqueous	5637	>500			
						MCF-7	>500			
					Methanol	MCF-7	>250			
	*Euryops arabicus*Steud.	Mosikran	Soqotra	Leaves, Flower	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
	Kleinia pendula(Forssk.) DC	Adhan	d.l.Y	Leaves, Flower	Methanol	5637	>250	NRU	Otitis	[7]
					Aqueous	5637	>500			
						MCF-7	>500			
					Methanol	MCF-7	>250			
			Yemen and Saudi Arabia	Leaves		MRC-5	>64	nd		[52]
	Psiadia punctulate (DC.) Vatke	Fatah	d.l.Y	Leaves, Flower	Methanol	5637	41.9	NRU	Rheumatic diseases	[7]
					Aqueous		300			
						MCF-7	>500			
					Methanol		93			

	Pulicaria crispa (P. undulata)	Khao, Juthjath	Abyan - Zingibar	Leaves	Essential Oil	MCF-7	64.6	MTT	an insect repellent, galactagogue, antiepileptic, and a tonic	[37]
			Taiz	Aerial parts	Methanol	ECV-304	>50	MTT	Analgesic	[17]
					Petroleum ether/ ethylacetate (1:1)	ECV-304	10.4			
	*Pulicaria inuloides*DC.	nd	d.l.Y	Leaves	Methanol	5637	42.3	MP	For wounds	[9]
						A-427	41.8			
						MCF-7	48.9			
	*Pulicaria jaubertii*Jaub. et Spach. (*P. orientalis*Jaub. et Spach.)	Khaoah, Unsif	d.l.Y	Leaves, Flower	Methanol	5637	>250	NRU	Anthelmintic, carminative and for digestive disorders	[7]
					Aqueous		>500			
						MCF-7	>500			
					Methanol		>250			
			Hajjah	Aerial parts	Methanol	HePG-2	24.1	CV	to treat inflammation, fever and as an insect repellent	[57]
						MCF-7	20			
						PC-3	19.1			
			Hajjah-Aljar region		Methanol	HePG-2	24.1	MTT	herbal teas, insect repellant, and alleviate inflammations	[49]
					n-heptane		51.8			
					Methanol	MCF-7	20			
					n-heptane		90.8			
					Methanol	PC-3	19.1			
					n-heptane		62.2			
			Hodiedah - Tihama	Leaves	Ethanol	FL	18	NRU	Gastro-intestinal tract pains andfever	[32]
			Sana'a	Fresh aerial part	Essential Oil	3T3	0.06	MTT	nd	[27]
						CEMss	0.025			
						CHO	0.08			
						HeLa	0.13			
						MCF-7	0.112			
						MDA-MB 231	0.11			
						WEHI-3B	0.028			
	*Pulicaria petiolaris*Jaub. & Spach	nd	d.l.Y	Leaves, Flower	Methanol	5637	40.2405	NRU	Eye inflammations	[7]
					Aqueous	MCF-7	>500			
					Methanol		>250			
	Pulicaria	Tebta	Soqotr	Leav	Methanol	5637	>50	M	nd	[54]

	***stephanocarpa*Balf. f.**	**b**	**a**	**es, Flower**		**A-427**	**36.5**	**P**		
						LCLC-103H	**>50**			
						MCF-7	**>50**			
						RT-4	**36.4**			
	***Tagetes minuta*L.**	**Shoqor Alhamir, Narjis**	**Dhamar**	**Leaves**	**Essential Oil**	**MCF-7**	**54.7**	**MTT**	**anthelmintic, diuretic, antispasmodic to treat stomach and intestinal diseases**	**[36]**
			Sana'a	**Fresh aerial part**		**3T3**	**nd**		**nd**	**[27]**
						CEMss	**0.03**			
						CHO	**0.0125**			
						HeLa	**0.054**			
						MCF-7	**0.02**			
						MDA-MB 231	**0.003**			
						WEHI-3B	**nd**			
	***Taraxacum officinale*F.H. Wigg**	**Alhindiba'**	**d.l.Y**	**Leaves, Stem**	**Methanol**	**5637**	**>250**	**NRU**	**Gastrointestinal troubles**	**[7]**
					Aqueous		**>500**			
					Aqueous	**MCF-7**	**>500**			
					Methanol		**>250**			
			Yemen and Saudi Arabia	**Leaves**	**Methanol**	**MRC-5**	**>64**	**nd**		**[52]**
	***Tarchonanthuscamphoratus*L.**	**Bayad or Mukar**	**d.l.Y**	**Leaves, Flower**	**Methanol**	**5637**	**4.7**	**MP**	**For wounds urinary tract infections stomach ailments, bronchitis, sinus-related complaints, relief for headaches, fumigation during funeral rituals,**	**[9]**
						A-427	**5.9**			
						MCF-7	**5.1**			
			Taiz-Alselw district	**Leaves**	**Essential Oil**	**HT-29**	**84.7**	**XTT**		**[33]**

									hot poultices for treating chest complaints and toothache	
	*Vernonia leopoldii*Vatke	Boyadh	d.l.Y	Leaves, Flower	Methanol	5637	34.2	MP	For cough, colic and skin diseases	[9]
						A-427	39.6			
						MCF-7	41.5			
			Ibb	Aerial parts	isolated compound 1 (1α-methoxy, 8α-methacryloyloxy-hirsutinolide-13-O-acetate)	HCT-116	24.79	MTT		[48]
							24.3			
							25.7			
						HEP-2	21.48			
							26.21			
							28.37			
						HePG-2	53.43			
							37.77			
							58.76			
						MCF-7	47.19			
							20.19			
							26.67			
basidiomycetes-Agaricaceae	*Agaricus devoniensis*P. D. Orton	nd	Abyan	Fruit	Methanol	FL	630	NRU	nd	[62]
	Agaricus sp. Type I	nd					560			
	Agaricus sp. Type III	nd					670			
	Agaricus sp. Type IV	nd					590			
	Battarrea stevenii(Liboschitz) Fr	nd					390			
	Gryophragmium dunali (Fr.) Zeller	nd					nd			
	Lepiota sp.	nd					nd			
	*Montagnea haussknecht*Rabenh	nd					450			
	Montagnea radiosa(Pallas) Sebek	nd					430			
	Podaxis pistillaris(L.: Pers.) Fr. emend. Morse	nd					450			
	Queletia sp.	nd					nd			
	*Tulostoma obesum*Cooke & Ellis	nd					330			
basidiomy	*Amanita nana*	nd					nd			

cetes-Amanitaceae										
basidiomycetes-Anacardiaceae	*Schizostoma laceratum*Ehrenb.	nd					750			
basidiomycetes-Fomitopsidaceae	*Laetiporus baudonii*(Pat.) Ryvarden	nd					nd			
basidiomycetes-Ganodermataceae	*Ganoderma colossus*(Fr.) Baker	nd					550			
	*Ganoderma resinaceum*Boud	nd					290			
basidiomycetes-Hymenochaetaceae	*Inonotus ochroporus*(Van der Byl) Pegler	nd					380			
	Phellinus rimosus(Berk.) Pilat	nd					880			
basidiomycetes-Phellriniaceae	*Phellorinia herculean* (Pallas: Pers.) Kreisel	nd					390			
basidiomycetes-Pluteaceae	*Pluteus sp.*	nd					nd			
basidiomycetes-Polyporaceae	*Coriolopsis caperata*(Berk.) Murrill	nd					980			
	Lentinus strigosus(Schwein. : Fr.) Fr.	nd					nd			
Bignoniaceae	*Tecoma stans*(L.) H.B.K.	Tecoma	d.l.Y	Leaves, Fruit	Methanol	5637	>250	NRU	Diabetes	[7]
					Aqueous		316			
						MCF-7	>500			
					Methanol		>250			
			Yemen and Saudi Arabia			MRC-5	>64	nd		[52]
Boraginaceae	*Alkanna orientalis*(L.) Boiss.	Lapid	d.l.Y	Root	Hot aqueous	FL	>1000	NRU	Common cold, pharyngitis, rheumatism and toothache	[6]
					Methanol		700			
	Cystostemon socotranus Balf. f.	nd	Soqotra	Leaves, Stem	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			

Brassicaceae	*Lepidium sativum*L.	Hilf	Hadhramaut	Seeds	Methanol	ECV-304	>50	MTT	Expectorant,antitussive, asthma	[17]
					Petroleum ether/ ethylacetate (1:1)		>50			
Burseraceae	*Boswellia ameero* Balf. f.	Ame`ero	Soqotra	Bark	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
	*Boswellia dioscorides*Thulin & Gifri	Ame`ero	Soqotra	Bark	Methanol	5637	29	MP	Common cold, bronchitis, asthma and rheumatism	[55]
						A-427	27.6			
						MCF-7	>50			
	Boswellia elongate Balf. f.	Ame`ero	Soqotra	Bark	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
	*Boswellia sacra*Flueck	Luban	Abyan-Ahwar	Resin	Methanol	ECV-304	32.1	MTT	Antitussive, pharyngitis	[17]
	*Boswellia socotrana*Balf.f.	Taliy'oh	Soqotra	Resin	Aqueous	FL	535.1	NRU	Stomatitis	[31]
					Chloroform		454.6			
					Methanol		507.1			
				Bark		5637	18.4	MP	Common cold, bronchitis, asthma and rheumatism	[55]
						A-427	24.9			
						MCF-7	>50			
						MRC-5	32.2	nd	Common cold, bronchitis, asthma and rheumatism	[11]
	*Commiphora foliacea*Sprague	Rashaha	Abyan-Alraqub	Stem cortex	Methanol	FL	430	NRU	Wound, antiseptic	[18]
	Commiphora gileadensis	Balsam	Abyan-	Leaves	MeOH·H2O	HePG-2	100	CC	nd	[13]

			Lawder					K-8		
	Commiphora kua (R.Br. ex Royle) Vollesen	Murr, Khadash	Abyan - Gischan	Leaves	Methanol	FL	25	NRU	Detergent for mouth and throat,bronchitis, face and skin antiseptic, cough	[18]
	Commiphora myrrh(Nees) Engl.	Murr	purchased from Sana`a	Oleo-gum-resin	isolated compound 1 (2-methoxyfuranodiene)	HePG-2	4.8	MTT	nd	[39]
					isolated compound 2 (2-acetoxyfuranodiene)		3.6			
					isolated compound 1 (2-methoxyfuranodiene)	HUVEC	8.5			
					isolated compound 2 (2-acetoxyfuranodiene)		4.9			
					isolated compound 1 (2-methoxyfuranodiene)	MCF-7	7.5			
					isolated compound 2 (2-acetoxyfuranodiene)		4.4			
	Commiphoraopobalsamum(Forssk.) Engl.	myrrh	Hadhramaut	Stem Bark	Chloroform	HePG-2	17	MTT	treat headache, urinary retention and constipation	[42]
					Ethanol		19			
					Ethyl acetate		47			
					Fat extract		45			
					n-butanol		>200			
					n-heptane		45			
					Chloroform	MCF-7	14			
					Ethanol		15			
					Ethyl acetate		41			
					Fat extract		40			
					n-butanol		>200			
					n-heptane		40			
	Commiphora ornifolia(Balf.f.) Gillett	Ikshih	Soqotra	Bark	Aqueous	FL	453.2	NRU	Antiseptic	[31]
					Chloroform	FL	39.3			
					Methanol	FL	495.9			
					Methanol	5637	30.2	MP	Antiseptic, diarrhoea, dysentery	[55]
					Methanol	A-427	35.1			
					Methanol	MCF-7	38.5			

									and emmenagogue	
					Methanol	MRC-5	>64	nd	Antiseptic, diarrhoea, dysentery and emesis	[11]
	*Commiphora parvifolia*Balf. f.	Laqim	Soqotra	Bark	Methanol	5637	41.7	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
Buxaceae	*Buxus hildebrandtii*Baillon	Maqhun	Soqotra	Leaves	Methanol	5637	10.9	MP	nd	[54]
						A-427	0.32			
						LCLC-103H	10.6			
						MCF-7	15.1			
						RT-4	6.46			
Cactaceae	*Chenopodium murale*L.	Remram	Taiz	Leaves	Ethanol	FL	28	NRU	Skin infection	[32]
Caesalpiniaceae	*Tamarindus indica*L.	Humar	Hadhramaut	Flower	Methanol	FL	9	NRU	Skin antiseptic, insecticides	[18]
Capparaceae (Cleomaceae)	*Cadaba farinose* Forssk.	Gurduma	Taiz	Leaves	Methanol	FL	720	NRU	Urinary infection, haemorrhoids	[18]
	Cadaba glandulosa Forssk.	Gurduma	Abyan-Gaheen	Leaves	Methanol	FL	800	NRU	Haemorrhoids	[18]
	*Capparis cartilaginea*Decne.	Rosuf, Khislif lattssaf, laşaf nişaf	Soqotra	Leaves	Methanol	5637	>50	MP	to treat itching, shortness of breath, head cold, tumors, wounds, boil and for painful knees	[55]
						A-427	>50			
						MCF-7	>50			
			Amran- AL-Madan	Leaves		A-549	>1000	MTT		[51]
				Stem		A-549	240			
				Twig		A-549	57.5			
				Leaves		HTC-116	>1000			
				Stem		HTC-116	871			

				Twig		HTC-116	656			
				Leaves		MCF-7	602.5			
				Stem		MCF-7	407			
				Twig		MCF-7	380			
			Taiz	Leaves	Ethanol	FL	350	NRU	Wounds, boils	[32]
	*Capparis spinosa*L.	Losuf Shawk	d.l.Y	Leaves	Methanol	5637	140	NRU	Tumors, kidney diseases, cholagogue, expectorant and general tonic	[7]
							>500			
						MCF-7	>500			
							>250			
	*Cleome schweinfurthii*Gilg.	nd	Ibb	Leaves, Fruit	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
			d.l.Y	Leaves, Stem	Hot aqueous	FL	>1000	NRU	Otitis	[6]
					Methanol		515			
	*Cleome socotrana*Balf. f.	nd	Soqotra	Leaves, Fruit	Methanol	RT-4	>50	MP	nd	[54]
						5637	>50			
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
	*Maerua angolensis*D.C.	Eshhib	Soqotra	Leaves	Methanol	5637	>50	MP	To treat fever, aches and general malaise	[55]
						A-427	>50			
						MCF-7	>50			
						MRC-5	>64	nd	To treat fever, aches and general malaise	[11]
	Maerua oblongifolia vel macrantha	Gurduma	Abyan-Gaheen	Gall	Methanol	FL	740	NRU	Asthma, skin diseases	[18]
Caricaceae	*Carica papaya*L.	Bobaya	Abyan	Seeds	Ethanol	FL	185	NRU	Wounds	[32]

Caryophyllaceae	***Pollichia campestris*Ait**	**nd**	**Sana'a**	**Leaves, Stem**	**Methanol**	**5637**	**>50**	**MP**	**nd**	[54]
						A-427	**>50**			
						LCLC-103H	**>50**			
						MCF-7	**>50**			
						RT-4	**>50**			
			d.l.Y	**Leaves, Flower**		**5637**	**>50**		**For sore throat and skin diseases**	[9]
						A-427	**>50**			
						MCF-7	**>50**			
Chenopodiaceae	***Chenopodiumambrosioides* L.**	**Zarbikh**	**d.l.Y**	**Leaves**	**Methanol**	**5637**	**>50**	**MP**	**Anthelmintic, for skin and kidney diseases a vermifuge, emmenagogue and abortifacient, diuretic and an anthelmintic, also it used to treat wounds, respiratory problems, inflammatory and painful processes, bronchitis, tuberculosis, and rheumatism. Externally, for haemorrhoids, as a poultice to detoxify snake bites and other poisons and is thought to have wound-healing properties**	[9]
						A-427	**>50**			
						MCF-7	**>50**			
			Sana'a	**Fresh whole plant**	**Essential Oil**	**3T3**	**0.023**	**MTT**		[27]
						CEMss	**0.025**			
						CHO	**0.035**			
						HeLa	**0.055**			
						MCF-7	**0.021**			
						MDA-MB 231	**0.02**			
						WEHI-3B	**0.0125**			
			Taiz-Alselw district	**Leaves**		**HT-29**	**growth inhibition of 100 and 56%**	**nd**		[21]
Commeli	***Commelina***	**nd**	**d.l.Y**	**Leav**	**Methanol**	**5637**	**>250**	**N**	**Skin**	[7]

naceae	*diffusa*Burm. F.			es, Stem			>500	R U	diseases like dandruff, scurf and lichen	
						MCF-7	>500			
							>250			
Crassulaceae	*Kalanchoe farinacea* Balf. f.	Bigelowhin	Soqotra	Leaves, Flower	Methanol	5637	>50	M P	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
Cucurbitaceae	*Coccinia grandis*(L.) Voigt	nd	d.l.Y	Fruit	Methanol	5637	>50	M P	Anthelmintic, diuretic and for pneumonia	[9]
				Leaves		5637	>50			
				Fruit		A-427	>50			
				Leaves		A-427	>50			
				Fruit		MCF-7	>50			
				Leaves		MCF-7	>50			
			Yemen and Saudi Arabia	Fruit		MRC-5	>64	nd		[52]
				Leaves		MRC-5	>64			
	*Dendrosicyos socotrana*Balf. f.	Qamhayn	Soqotra	Leaves, Stem	Methanol	5637	0.4	M P	Urinary retention, cystitis, diabetes and problem with liver	[54]
						A-427	0.75			
						LCLC-103H	1.33			
						MCF-7	1.47			
						RT-4	1.66			
						MRC-5	0.7	nd		[11]
	*Eureiandra balfourii*Cogn.	di-ahsaweh	Soqotra	Root	Aqueous	FL	nd	N R U	toxic	[31]
					Chloroform		<10			
					Methanol		nd			
				Leaves		5637	0.82	M P	Unknown	[55]
						A-427	2.25			
						MCF-7	3.47			
						MRC-5	20.9	nd		[11]
	Kedrostis foetidissima(Jacq.) Cogn	nd	d.l.Y	Leaves, Root	Methanol	5637	121	N R U	Warts	[7]
					Aqueous		>500			
					Methanol	MCF-7	>500			
							>250			
			Yemen and Saudi Arabi	Leaves, Stem		MRC-5	>64	nd		[52]

			a							
	Zehneria anomala C. Jeffrey	Madh	Imkhudeera	Gall	Methanol	FL	>1000	NRU	Skin diseases, burns, wound	[18]
Cupressaceae	*Cupressus sempervirens*L.	Saro	d.l.Y	Leaves	Methanol	5637	16.2	MP	Expectorant, astringent and for wounds, diarrhoea and haemorrhoids	[9]
						A-427	10.1			
						MCF-7	13.7			
Dictyotaceae	*Dictyota dichotoma*	nd	seacoasts of Hodeida city	Algae	Aqueous	A-549	>100	CVS	nd	[43]
					Chloroform		3.19			
					Ethyl acetate		5.14			
					Methanol		13.8			
					n-butanol		90.9			
					Petroleum ether		6.09			
					Aqueous	CACO	>100			
					Chloroform		2.71			
					Ethyl acetate		5.06			
					Methanol		nd			
					n-butanol		>100			
					Petroleum ether		5.39			
					Aqueous	HCT-116	>100			
					Chloroform		3.11			
					Ethyl acetate		5.5			
					Methanol		22.8			
					n-butanol		86			
					Petroleum ether		5.32			
					Aqueous	HeLa	>100			
					Chloroform		3.8			
					Ethyl acetate		11.1			
					Methanol		17.2			
					n-butanol		>100			
					Petroleum ether		5.68			
					Aqueous	HePG-2	79			
					Chloroform		2.95			
					Ethyl acetate		5.06			
					Methanol		7.7			
					n-butanol		41.2			
					Petroleum ether		9.31			
					Aqueous	MCF-7	84.6			
					Chloroform		1.93			
					Ethyl acetate		5.33			
					Methanol		11			
					n-butanol		70.5			
					Petroleum ether		4.77			
					Aqueous	PC-3	87.2			
					Chloroform		2.2			
					Ethyl acetate		5.52			
					Methanol		13.4			
					n-butanol		80.8			
					Petroleum ether		3.93			

Dracaenaceae (Agavaceae)	*Dracaena cinnabari*Balf. f.	Damalakhwain	Soqotra	Leaves, Flower, Resin	Methanol	5637	2.59	MP	Face and skin antiseptic	[54]
						A-427	5.54			
						LCLC-103H	4.77			
						MCF-7	3.46			
						RT-4	3.99			
			Soqotra	Resin		H103	6	MTT		[28]
						H314	17.4			
						H357	9			
						H376	7.2			
						H400	5.9			
						H413	19.2			
						ECV-304	8.9			[17]
					Ethyl acetate	FL	553.5			
					Methanol	FL	300			
					Residual fraction dissolved n methanol	FL	600.4			
					Methanol	MRC-5	7.7	nd		[11]
					isolated compound 1 (2,4'-dihydroxy-4-methoxydihydrochalcone)	HePG-2	20.56	MTT		[53]
							6.36			
	*Sansevieria ehrenbergii*Schweinf. ex Baker	Seni	Abyan-Lawder	Fruit	Methanol	FL	30	NRU	Warts, antiseptic	[18]
Ebenaceae	*Euclea divinorum*Hiern	Miswak, Kala	Soqotra	Root Bark	Dichloromethane (methylene chloride)	FL	240	NRU	toothbrush	[15]
					Methanol	FL	900.5	NRU		
					Sequential ethyl acetate	FL	387.7	NRU		
					Sequential Methanol	FL	800.6	NRU		
				Root	Methanol	5637	>50	MP	For oral care, tooth ache, fungal diseases,	[55]
						A-427	>50			
						MCF-7	>50			
						MR	27.5	nd		[11]

						C-5			sores, wounds and abscesses	
					Petroleum ether/ethylacetate (1:1) extrac	ECV-304	36 11.6	MTT	Mouth antiseptic, skin disease	[17]
Euphorbiaceae	*Acalypha ciliate* Forssk.	nd	d.l.Y	Leaves	Methanol	5637	>50	MP	Anthelmintic and for scabies and malaria	[9]
						A-427	>50			
						MCF-7	>50			
			Yemen and Saudi Arabia			MRC-5	>64	nd	Malaria, anthelmintic, and scabies	[52]
	Acalypha fruticose Forssk.	Einshit	Al-Mahweet	Aerial parts	Aqueous	HCT-116	48.6	MTT	to treat wounds, skin diseases and malaria	[25]
					Chloroform		4.81			
					Ethyl acetate		>100			
					Methanol		37.6			
					n-butanol		>100			
					n-heptane		10.1			
					Aqueous	HePG-2	77.7			
					Chloroform		5.21			
					Ethyl acetate		>100			
					Methanol		73.9			
					n-butanol		>100			
					n-heptane		15.4			
					Aqueous	MCF-7	62.6			
					Chloroform		12.2			
					Ethyl acetate		>100			
					Methanol		84.9			
					n-butanol		>100			
					n-heptane		23.1			
					Aqueous	MRC-5	>100			
					Chloroform		20.4			
					Ethyl acetate		>100			
					Methanol		>100			
					n-butanol		>100			
					n-heptane		85.2			
			Hajjah	Leaves, Stem	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
					Hot aqueous	FL	>1000	NRU	Skin diseases, malaria and wounds	[6]
					Methanol	FL	70			
			Yemen and Saudi Arabia	Leaves		MRC-5	>64	nd		[52]
	Cephalocroton	tan	Soqotr	Leav	Aqueous	FL	411.	N	Anti-	[31]

	socotranus Balf. F.		a	es, Flower			7	RU	infective	
					Chloroform		430.7			
					Methanol		544.4			
	Chrozophora oblongifoli(Del.) A. Juss. ex Spreng.	Om Alnar, Tanoon	d.l.Y	Leaves, Stem	Methanol	5637	>250	NRU	Antiseptic for wounds and for haemorrhoids	[7]
					Aqueous		298			
					Methanol	MCF-7	>500			
							>250			
	*Croton socatranus*Balf. F.	Matrar	Soqotra	Aerial parts	Methanol	A-549	39.7	MTT	Wounds, anthelmintic	[20]
						CACO-2	32.2			
						CHO-K1	36.6			
						HCT-116	37.2			
						HeLa	38.9			
						HEP-2	46.1			
						HePG-2	21			
						MCF-7	22.5			
						MNFS-60	98.7			
						PC-3	41.7			
						RD	23			
				Leaves, Fruit		5637	>50	MP		[55]
						A-427	>50			
						MCF-7	>50			
						MRC-5	>64	nd		[11]
	Euphorbia cactus Ehrenb.	Qasas	Dhamar	Flower	Methanol	ECV-304	16	MTT	Wound healing	[17]
					Petroleum ether/ ethylacetate (1:1)		>50			
	*Euphorbia hadramaut*Baker	Nafeez	Al-Mahra	whole parts	Methanol	FL	>1000	NRU	Bruises, eczema, wound	[18]
	*Euphorbia schimperi*Presl	Edhin	d.l.Y	Leaves	Methanol	5637	23.2	MP	Antiseptic and for warts	[9]
						A-427	1.9			
						MCF-7	>50			
	*Euphorbia socotrana*Balf.f	Dawkash, Marah	Soqotra	Leaves	Methanol	5637	42	MP	For skin diseases and wounds	[55]
						A-427	38.1			
						MCF-7	>50			
						MRC-5	8.9	nd	For skin diseases	[11]

									and wounds	
	Jatropha spinosa(Forssk.) Vahl	Ebki	Taiz	Root	Dichloromethane (methylene chloride)	A-549	0.53	SRB	treat respiratory tract infections, as an antiseptic of wounds, as a haemostatic to stop bleeding, and for many other purposes	[58]
				Aerial parts	Methanol		20			
							38			
				Root	Dichloromethane (methylene chloride)	HeP G-2	0.24			
				Aerial parts	Methanol		24			
							12.5			
				Root	Dichloromethane (methylene chloride)	HSF	0.34			
				Aerial parts	Methanol		nd			
							1.08			
				Root	Dichloromethane (methylene chloride)	MCF-7	1			
				Aerial parts	Methanol		21			
				Root			10			
	Jatropha unicostate Balf. f.	Sabrah	Soqotra	Bark	Methanol	5637	>50	MP	nd	[54]
						A-427	0.97			
						LCLC-103H	14.2			
						MCF-7	>50			
						RT-4	21.6			
	Jatropha variegate Vahl	Ebki	d.l.Y	Leaves, Fruit	Hot aqueous	FL	>1000	NRU	Antiseptic, for wounds and haemostatic	[6]
					Methanol		100			
			Taiz	Root	Dichloromethane (methylene chloride)	A-549	0.7	SRB	treat respiratory tract infections, as an antiseptic of wounds, as a haemostatic to stop bleeding, and for	[58]
				Leaves	Methanol		23			
				Root			16.5			
				Stem			37			
				Root	Dichloromethane (methylene chloride)	HeP G-2	0.64			
				Leav	Methanol		21			

				es					many other purposes	
				Root			4			
				Stem			19			
				Root	Dichloromethane (methylene chloride)	HSF	0.69			
				Leaves	Methanol		nd			
				Root			1.54			
				Stem			nd			
				Root	Dichloromethane (methylene chloride)	MCF-7	1.4			
				Leaves	Methanol		20			
				Root			4			
				Stem			32			
			Taiz	Aerial parts	Methanol	A-549	84.1	MTT	to treat wounds and as a contraceptive	[44]
						Bj-1	59.9			
						PC-3	39.4			
	Tragia pungens(Forssk.) Muell.-Arg.	Harika	Taiz	Leaves, Stem	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
			d.l.Y		Hot aqueous	FL	>1000	NRU	Allergy and skin diseases	[6]
					Methanol		70			
Fabaceae (Mimosaceae)	*Acacia asak*Willd.	Talah	Aldha'la	Stem cortex	Methanol	FL	>1000	NRU	Gastric ulcer, antiseptic, skin diseases	[18]
	Acacia nilotica (L.) Delile	Qarad	Ya'fa	Leaves	Methanol	FL	>1000	NRU	Expectorating, wounds, pharyngitis, bronchitis, diabetes	[18]
	Acacia penniveniaSchweinf	Tamhar	Soqotra	Leaves	Methanol	5637	>50	MP	As a paste around the breast for women with mastitis	[55]
						A-427	>50			
						MCF-7	>50			
						MRC-5	28.1	nd	As a paste around the breast for women with	[11]

									mastitis	
	Acacia tortilis Hayne	Somer, Sumyrr	Abyan-Lawder	Seeds	Methanol	ECV-304	>50	MTT	Gastrointestinal disease	[17]
					Petroleum ether/ethylacetate (1:1) extrac		>50			
			Shabwah	Fruit	Methanol	FL	>1000	NRU	Stomach ache, digestive	[18]
	Albizia lebbeck L.	Meetti	Abyan	Seeds	Ethanol	FL	178	NRU	Skin infection	[32]
	*Flemingia grahamiana*Wight & Arn.	nd	Yafa area, Yemen	Pods	Aqueous	MCF-7	nd	MTT	nd	[12]
					Methanol		nd			
	*Indigofera oblongifolia*Forsk.	Waras, Hasar	Abyan	Leaves	Ethanol	FL	345	NRU	Urinary tract infection, urolithiasis, cough	[32]
	Indigofera spinosa Forsk.	Hassar	Imaeen	Leaves	Methanol	FL	>1000	NRU	Kidney stones, cough, cold	[18]
	Prosopis julifloraDC.	Sesaban	Aden	Fruit	Methanol	ECV-304	>50	MTT	Skin disease	[17]
					Petroleum ether/ethylacetate (1:1) extract		>50			
Gentianaceae	*Enicostemma verticillare*(Retz.) Baill.	nd	d.l.Y	Leaves	Methanol	5637	>50	MP	For diabetes	[9]
						A-427	>50			
						MCF-7	>50			
	Exacum affine Balf. f. ex Regel	Ashrab	Soqotra	Leaves, Flower	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
Hydnoraceae	*Hydnora abyssinica*A.Br.	Tafhoot	Abyan-Lawder	Flower	Dichloromethane (methylene chloride)	FL	>500	NRU	the flowers have traditionally been used as wild food and to cure stomach diseases, gastric ulcer and cancer.	[16]
					Ethyl acetate		>500			
					Methanol		>500			
Iridaceae	*Iris albicans*Lange	Zaranbuq	d.l.Y	Root	Hot aqueous	FL	>1000	NRU	Rheumatism and gout	[6]
					Methanol		15			
Lamiacea	*Ajuga*	nd	d.l.Y	Leav	Methanol	5637	>50	M	Antiseptic	[9]

e (Labiatae)	*bracteosa*Wall. ex Benth.			es, Flower		A-427	>50	P	and for teeth pains	
						MCF-7	>50			
	*Lavandula dentata*L.	nd	d.l.Y	Leaves, Flower	Methanol	5637	>50	MP	For wounds and rheumatism	[9]
						A-427	>50			
						MCF-7	>50			
	*Lavandula pubescens*Decne	Dhafar	Amran	Aerial parts	Essential Oil	AGS	<10	MTT	diuretic, antiseptic and for broncho-pulmonary and skin infections	[14]
						HeLa	<10			
			d.l.Y	Leaves, Flower	Hot aqueous	FL	>1000	NRU	Antiseptic, carminative and diuretic,	[6]
					Methanol		625			
			Ibb	Leaves	Essential Oil	MCF-7	55.05	MTT	diuretic, antiseptic, carminative and as a remedy for broncho-pulmonary infection	[41]
						MDA-MB 231	98			
			Taiz			MCF-7	16.75			
						MDA-MB 231	96.08			
	*Leucas inflata*Benth.	nd	d.l.Y	Leaves, Flower	Methanol	5637	>50	MP	For kidney diseases and tooth ache	[9]
						A-427	>50			
						MCF-7	>50			
	*Leucas samhaensis*Cortes-Burns & A.G.Mill.	nd	Soqotra	Leaves	Methanol	5637	>50	MP	For cough and cold	[55]
						A-427	>50			
						MCF-7	>50			
	*Leucas virgata*Balf. F.	Sueal hun	Soqotra	Leaves	Methanol	5637	>50	MP	For persons with heartburn and indigestion and stomach problems	[55]
						A-427	>50			
						MCF-7	>50			
			Yemen and Saudi Arabia	Leaves, Fruit	Methanol	MRC-5	>64	nd	Heartburn, indigestion, and stomach problems	[52]
	Mentha longifolia(L.) Hudson	Habaq, Na`adh	d.l.Y	Leaves, Stem	Hot aqueous	FL	>1000	NRU	Spasmolytic and digestive disorders	[6]
					Methanol		820			
	Mentha piperita	Nean	Amra	Fres	Essential Oil	3T3	0.12	M	nd	[27]

		a`a	n	h leaves		CE Mss	0.0125	TT		
						CHO	no activity			
						HeLa	no activity			
						MCF-7	no activity			
						MDA-MB 231	0.21			
						WEHI-3B	0.02			
	Meriandra benghalensis(Roxb.) Benth	Dhuru	d.l.Y	Leaves	Methanol	5637	>50	MP	Antiseptic for wounds and for urinary tract infections	[9]
				Root		5637	0.9			
				Leaves		A-427	>50			
				Root		A-427	2.5			
				Leaves		MCF-7	>50			
				Root		MCF-7	0.4			
			Dhamar-Wesab	Leaves	Essential Oil	HT-29	good	XTT	carminative, antirheumatic, astringent and an antiseptic plant	[38]
			Ibb		Ethanol	FL	138	NRU	Skin infection	[32]
	*Nepeta deflersiana*Schweinf. ex Hedge	Muskirat Al'adamam	d.l.Y	Leaves	Methanol	5637	>50	MP	Antiseptic for wounds, rheumatic disorders, fever and colic	[9]
						A-427	>50			
						MCF-7	>50			
	*Ocimum basilicum*L.	Rihan, Habaq	Sana'a	Fresh leaves	Essential Oil	3T3	0.035	MTT	treating ailments like headaches, coughs, diarrhoea, worms, and kidney malfunctions	[27]
						CEMss	0.025			
						CHO	0.06			
						HeLa	no activity			
						MCF-7	no activity			
						MDA-MB 231	0.2			
						WE	0.01			

						HI-3B	85			
						MCF-7	weak			[59]
	*Ocimum forskolei*Benth.	Dhumaran	Dhamar	Leaves	Essential Oil	HT-29	not active	XTT	cosmetic, to relieve fever, and to treat skin infections	[35]
			Imsha'a	Herb	Methanol	FL	880	NRU		[18]
	Origanum majorana L.	Ozab	Sana'a	Fresh aerial part	Essential Oil	3T3	0.025	MTT	nd	[27]
						CEMss	0.036			
						CHO	0.04			
						HeLa	0.15			
						MCF-7	0.11			
						MDA-MB 231	0.11			
						WEHI-3B	0.035			
	Otostegia fruticose (Forssk.) Briq.	Shaqb	d.l.Y	Leaves	Methanol	5637	>250	NRU	Anti-paralytic and for eye diseases	[7]
					Aqueous		>500			
					Methanol	MCF-7	>500			
							>250			
			Taiz-Al-Mokab	Leaves	Essential Oil		55.1	MTT		[34]
						MDA-MB 231	72.3			
						MCF-7	51.9			[41]
						MDA-MB 231	100			
			Yemen and Saudi Arabia	Leaves, Flower	Methanol	MRC-5	>64	nd		[52]
	Plectranthus barbatus Andr.	Pedah	Taiz	Leaves	Essential Oil	MCF-7	38.62	MTT	ailments, particularly digestive, skin, infective and respiratory problems. It has also been used widely for food, flavour and	[41]
						MDA-MB 231	100			

									fodder	
	*Plectranthus cylindraceus*Hochst. Ex. Benth	Kharob, Madan	Dhamar-Wesab	Leaves	Essential Oil	HT-29	good	XTT	treating skin, digestive and respiratory diseases	[38]
	Plectranthus hadiensis(Forssk.)	Madan	d.l.Y	Leaves	Hot aqueous	FL	>1000	NRU	Antiseptic and haemostatic	[6]
				Root			>1000			
				Leaves	Methanol		150			
				Root			>1000			
	*Rosmarinus officinalis*L.	Iiklil aljabal	d.l.Y	Leaves, Flower	Methanol	5637	48.3	NRU	Antiseptic, carminative and cholagogue	[7]
					Aqueous	5637	>500			
					Aqueous	MCF-7	>500			
					Methanol	MCF-7	187			
			Sana'a	Fresh leaves	Essential Oil	3T3	0.038	MTT	nd	[27]
						CEMss	0.07			
						CHO	0.08			
						HeLa	0.08			
						MCF-7	0.06			
						MDA-MB 231	0.06			
						WEHI-3B	0.0125			
			Yemen and Saudi Arabia	Leaves, Stem	Methanol	MRC-5	22.1	nd	Antiseptic, cholagogue	[52]
	Stachys yemenensis Hedge.	Shehah, Baidh	Taiz	Leaves	Essential Oil	MCF-7	44.65	MTT	treatment of ulcer, skin, stomach and rheumatic disorders	[41]
						MDA-MB 231	100			
	Teucrium sokotranum Vierh.	Fajahn	Soqotra	Leaves, Flower	Methanol	5637	>50	MP	As flavouring agent and for indigestion	[55]
						A-427	>50			
						MCF-7	>50			
						MRC-5	>64	nd		[11]
	*Teucrium yemense*Deflers	Khawdas	d.l.Y	Leaves, Flower	Methanol	5637	>50	MP	For kidney diseases and rheumatism	[9]
						A-427	>50			
						MCF-7	>50			
			Dham	Leav	Essential Oil	HT-	43.7	X	antispasm	[35]

			ar	es		29		TT	odics and insect repellents	
			Taiz			MCF-7	24.4			
						MDA-MB 231	59.9			
						MCF-7	24.43	MTT	antispasmodics and insect repellents	[41]
						MDA-MB 231	97.04			
	*Thymus laevigatus*Vahl.	Za'tar	Hajjah	Leaves	Aqueous	FL	>1000	NRU	treatment of various disorders including stomach and respiratory system	[19]
					Dichloromethane (methylene chloride)		276.6			
					Methanol		298.8			
			Sana'a-Alhimah	Dried aerial parts	Essential Oil	3T3	0.0115	MTT	nd	[27]
						CEMss	0.007			
						CHO	0.023			
						HeLa	0.032			
						MCF-7	0.027			
						MDA-MB 231	0.018			
						WEHI-3B	0.0065			
Liliaceae	*Kniphofia sumarae*Deflers	Basalh	d.l.Y	Leaves, Flower	Methanol	5637	>50	MP	For malaria	[9]
						A-427	>50			
						MCF-7	>50			
Loganiaceae	*Buddleja polystachya*Fresen.	Ofar	Sada`a	Leaves, Flower	Methanol	5637	>50	MP	nd	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
			d.l.Y			5637	>50		For leprosy, vitiligo and warts	[9]
						A-427	>50			
						MCF-7	>50			
Loranthaceae	*Loranthus regularis*Steud. ex Sprague	nd	Yemen and Saudi Arabi	Root	Methanol	MRC-5	40.6	nd	Diabetes, kidney disease	[52]

			a							
	Phragmanthera regulari(Steud. Ex Sprague) M.G.Gilbert	Karad	d.l.Y	Leaves	Methanol	5637	212	NRU	Diabetes and kidney stones	[7]
					Aqueous	5637	260			
					Aqueous	MCF-7	>500			
					Methanol	MCF-7	>250			
	*Plicosepalus curviflorus*Tiegh.	Saquar	Abyan-Lawder	Stem	Methanol	FL	5	NRU	Cancer	[18]
Lythraceae	*Lawsonia inermis* L.	Henna	Hadhramaut	Leaves	Methanol	ECV-304	>50	MTT	Fungal skin disease, wound healing	[17]
					Petroleum ether/ethylacetate (1:1) extrac		>50			
			Hodiedah - Tihama		Ethanol	FL	75	NRU	Antiseptic, burns wounds	[32]
Malpighiaceae	*Acridocarpus socotranus*Olive	Kirilloh	Soqotra	Flower	Aqueous	FL	nd	NRU	Toxic to camels	[31]
				Leaves			687.1			
				Flower	Chloroform		510			
				Leaves			193.4			
				Flower	Methanol		464			
				Leaves			662.3			
				Leaves, Stem		5637	>50	MP	Headaches, paralysis and muscle or tendon pain	[55]
						A-427	>50			
						MCF-7	>50			
						MRC-5	>64	nd		[11]
Malvaceae	*Gossypium areysiamum* Defl.	Afra	Imsha'a	Leaves	Methanol	FL	>1000	NRU	Wound, dermatitis	[18]
	*Gossypium barbadense*L.	Uttub	Abya-Zingibar	Seeds	Methanol	FL	>1000	NRU	Cosmetic, acne, rheumatism	[18]
	*Hibiscus nolitangere*A.G.Mill.	nd	Soqotra	Leaves, Root	Methanol	5637	>50	MP	For snake bite and fever in children	[55]
						A-427	>50			
						MCF-7	>50			
						MRC-5	26.8	nd	For snake bite and fever in children	[11]
Meliaceae	*Melia azedarach* L.	Murimara	d.l.Y	Leaves, Flower	Methanol	5637	>250	NRU	Malaria, skin diseases, anthelmintic and kidney stones	[7]
						5637	>500			
						MCF-7	>500			
						MCF-7	>250			
			Hodiedah -	Leaves	Ethanol	FL	165	NR	Snake bites, skin	[32]

			Tihama					U	infection	
Moraceae	*Dorstenia barnimiana*Schweinf.	nd	d.l.Y	Leaves	Methanol	5637	>50	MP	For fungal diseases	[9]
						A-427	>50			
						MCF-7	>50			
	Dorstenia foetida(Forssk.) Schweinf. ex Balf. F.	Kasar	Taiz-Al Terbah	Leaves	*n*-heptane	HT-29	good	XTT	The juice of the aerial parts is used in local traditional medicine in Yemen for treating skin diseases and in particular leishmaniasis	[46]
						PC-3	good			
	*Dorstenia gigas*Schweinf. exBalf	Kartab	Soqotra	Leaves, Stem	Methanol	5637	>50	MP	Flatulence, indigestion and skin diseases	[54]
						A-427	>50			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
			Soqotra	Leaves, Flower	Aqueous	FL	500.2	NRU		[31]
					Chloroform		387.8			
					Methanol		490.4			
				Leaves, Stem		MRC-5	>64	nd		[11]
	*Ficus cordata*Thunb.	Itha`ab	Soqotra	Leaves	Methanol	5637	>50	MP	Antiseptic and for ulcers and wounds	[55]
						A-427	>50			
						MCF-7	>50			
	Ficus vasta Forssk.	Tawlaq	Rada'a	Fruit	Methanol	FL	980	NRU	Cough, expectorant	[18]
Myrtaceae	*Eucalyptus camaldulensis*Behnh.	Kafoor	Sana'a	Resin	Methanol	ECV-304	20.7	MTT	Mouth antiseptic, skin antiseptic	[17]
				Dried leaves	Essential Oil	3T3	0.011		nd	[27]
						CEMss	0.0063			
						CHO	0.023			
						HeL	0.13			

						a				
						MCF-7	0.107			
						MDA-MB231	0.055			
						WEHI-3B	0.0063			
				Leaves	Essential Oil	HT-29	110	MTT	nd	[40]
					Methanol	5637	135			
				Leaves, Fruit	Aqueous		258	NRU	Antiseptic, diuretic, for bronchitis, common cold and syphilis	[7]
					Aqueous	MCF-7	333			
	*Myrtus communis*L.	Hads	d.l.Y		Methanol		>250			
			Yafa area, Yemen	Leaves	Aqueous		20.49	MTT	nd	[12]
					Methanol		22.1			
Oxalidaceae	*Oxalis corniculate* L.	Humaidh	d.l.Y	Leaves	Methanol	5637	>250	NRU	Antiparasitic, antivertigo and for mouth inflammations	[7]
					Aqueous		>500			
					Aqueous	MCF-7	>500			
					Methanol		>250			
			Sana'a		Ethanol	FL	135		Gastrointestinal pain, antivertigo	[32]
			Yemen and Saudi Arabia	Leaves, Flower	Methanol	MRC-5	>64	nd	Antiparasitic, antivertigo, and mouth inflammation	[52]
Pandanaceae	*Pandanus odoratissimus*L.	Kathi	Taiz	Flower	Methanol	MCF-7	20.6	MTT	treat Nocturnal Enuresis in children	[30]
Piperaceae	*Peperomia blanda*(Jacq.) Kunth	nd	Soqotra	Leaves, Flower	Dichloromethane (methylene chloride)	HDFa	>100	MTT	treat skin diseases, burns, eye infections, and asthma and as antibiotics	[23]
					Methanol		>100			
					Petroleum ether		>100			
					Dichloromethane (methylene chloride)	HL-60	14.42			
					Methanol		28.62			
					Petroleum ether		9.54			
					Dichloromethane	MCF10	>100			

					(methylene chloride)	A				
					Methanol		>100			
					Petroleum ether		>100			
					Dichloromethane (methylene chloride)	MCF-7	30.56			
					Methanol		10.49			
					Petroleum ether		5.39			
					Dichloromethane (methylene chloride)	WEHI-3	15.58			
					Methanol		104.39			
					Petroleum ether		4.3			
					Dichloromethane (methylene chloride)	WRL68	>100			
					Methanol		>100			
					Petroleum ether		>100			
					Dichloromethane (methylene chloride)	HePG-2	20.85	SRB		[22]
					Methanol		13.06			
					Petroleum ether		24.39			
					Dichloromethane (methylene chloride)	MCF-7	10.7			
					Methanol		8.11			
					Petroleum ether		4.6			
Plumbaginaceae	*Limonium socotranum*(Vierh) Radcl.	lizibih	Soqotra	Leaves, Flower	Dichloromethane (methylene chloride)	HePG-2	20.62	SRB	remedy for dysentery or as a gargle or mouthwash for ulcerations	[22]
				Stem			11.15			
				Leaves, Flower	Methanol		13.9			
				Stem			24.86			
				Leaves, Flower	Petroleum ether		9.97			
				Stem			16.97			
				Leaves,	Dichloromethane	MCF-7	17.6			

				Flower	(methylene chloride)					
				Stem			21.8			
				Leaves, Flower	Methanol		8.7			
				Stem			17.18			
				Leaves, Flower	Petroleum ether		19.65			
				Stem			14.57			
				Leaves	Aqueous	FL	615.1	NRU	antifungal	[31]
					Chloroform		136.3			
					Methanol		522.1			
Polygonaceae	*Rumex nervosus*Vahl.	Uthrub	Dhamar	Leaves	Ethanol	FL	380	NRU	Pharyngitis, ophthalmic antiseptic	[32]
Pteridophyta	*Actiniopterissemiflabellata*Pic.-Ser.	Mosht Alghorab, Serbin	d.l.Y	Leaves	Hot aqueous	FL	>1000	NRU	Wounds and burns	[6]
					Methanol		950			
Punicaceae	*Punica protopunica*Balf. F.	nd	Soqotra	Leaves, Fruit	Methanol	5637	21.3	MP	nd	[54]
						A-427	16.5			
						LCLC-103H	18.8			
						MCF-7	>50			
						RT-4	37.6			
				Fruit		MRC-5	29.5	nd	Anthelmintic, peptic ulcers, dysentery, diarrhoea, sores and wounds	[11]
Ranunculaceae	*Nigella sativa*L.	Habasaoda	Hadhramaut	Seeds	Methanol	ECV-304	>50	MTT	Carminative, antitussive, antirheumatic	[17]
					Petroleum ether/ethylacetate (1:1) extrac		>50			
					Ethanol	FL	85	NRU	Cough	[32]
Resedaceae	*Ochradenus baccatus*Del.	Gershiy'oh, Mosh	d.l.Y	Leaves	Methanol	5637	>250	NRU	Diuretic, antiseptic, for cough	[7]
					Aqueous		>500			
						MC	>500			

		t alhada			Methanol	F-7	>250		and itching	
			Yemen and Saudi Arabia	Leaves, Flower	Methanol	MRC-5	>64	nd		[52]
	Ochradenus socotranus A.G. Mill	Gershiy'oh	Soqotra	Fruit	Aqueous	FL	nd	NRU	Insecticide	[31]
					Chloroform		511.8			
					Methanol		nd			
Rhamnaceae	*Ziziphus spina-christi*(L.) Willd.	Sidr, Eilb	Abyan	Leaves	Ethanol	FL	120	NRU	Wound powder, antiseptic	[32]
			d.l.Y	Leaves, Flower	Methanol	5637	>250		Asthma, warts anthelmintic, antiseptic and antipruritic	[7]
					Aqueous	5637	>500			
						MCF-7	>500			
					Methanol	MCF-7	>250			
Rubiaceae	*Carphalea obovata* (Balf.f.) Verdc.	Shyhat	Soqotra	Leaves	Methanol	5637	48.9	MP	nd	[54]
						A-427	9.38			
						LCLC-103H	>50			
						MCF-7	>50			
						RT-4	>50			
Salicaceae	*Oncoba spinosa*Forssk.	nd	d.l.Y	Fruit	Methanol	5637	230	NRU	Anthelmintic, for syphilis, wounds, and sexual impotence	[7]
					Aqueous		>500			
						MCF-7	>500			
					Methanol		>250			
Salvadoraceae	*Azima tetracantha*Lam.	Sor	Abyan - Lawder	Fruit	Methanol	FL	>1000	NRU	Rheumatism, cough	[18]
	*Salvadora persica*L.	Rak, Arak	Abyan	Root	Ethanol	FL	110	NRU	Mouth hygiene, gum inflammation	[32]
			Abyan - Modya		Methanol	ECV-304	>50	MTT	Mouth and teeth antiseptic, antidote	[17]
					Petroleum ether/ethylacetate (1:1) extrac		>50			
				Gall	Methanol	FL	>1000	NRU	Dermatitis	[18]
			d.l.Y	Leaves		5637	nd		Gingivitis, mouth wounds and warts	[7]
					Aqueous					
					Methanol	MCF-7				
Sapindace	*Dodonaea*	Sheht	d.l.Y	Leav	Hot aqueous	FL	>100	N	Malaria,	[6]

ae	*viscosa*(L.) Jacq.	h		es, Stem	Methanol		0 650	R U	wounds and burns	
Scrophulariaceae	*Lindenbergia indica*(L.)Kuntze	nd	Hajjah	Leaves, Flower, Stem	Methanol	5637 A-427 LCLC-103H MCF-7 RT-4	>50 >50 >50 >50 >50	MP	For sprains, swellings and sores	[54]
				Leaves, Root		5637 A-427 MCF-7	>50 >50 >50			[9]
	Verbascum bottae(Deflers) Huber-Mor.	nd	d.l.Y	Leaves, Flower	Hot aqueous	FL	>1000	NRU	Cough, skin diseases and rheumatism	[6]
			Yemen and Saudi Arabia		Methanol	MRC-5	>1000 32.5	NRU nd		[52]
Solanaceae	*Lycium shawii*Roem. & Schult	Zawrab, Awsaj	d.l.Y	Leaves	Methanol	5637	44	NRU	Kidney stones, diuretic, spasmolytic and pains in the eye	[7]
					Aqueous	MCF-7	>500 >500			
					Methanol		67			
	*Lycium sokotranum*Wagner & Vierh	Sohar	Soqotra	Leaves, Stem	Methanol	5637 A-427 MCF-7	>50 >50 >50	MP	For stomach ailments and encourage the wound healing	[55]
						MRC-5	20.9	nd	For stomach ailments and encourage the wound healing	[11]
	*Solanum glabratum*Dunal	Hadaq	d.l.Y	Leaves, Fruit	Methanol	5637 A-427 MCF-7	9.4 9 8.6	MP	Diuretic, for scabies, syphilis, cough and haemorrhoids	[9]
			Yemen and Saudi Arabia			MRC-5	27.9	nd		[52]
	Solanum incanum L.	Nuqum, Orsom	Hadhramaut	Fruit	Methanol	FL	35	NRU	Teeth antiseptic, toothache, skin	[18]

									diseases	
	Solanum nigrum L.	Qumqam, Onomnom	Lahaj	Fruit	Methanol	FL	450	NRU	Skin antiseptic, diarrhoea, expectorant, laxative, haemorrhages	[18]
	*Withania adunensis*Vierh.	U'beb	Soqotra	Leaves, Fruit	Methanol	5637	1.07	MP	nd	[54]
						A-427	0.3			
						LCLC-103H	1.07			
						MCF-7	0.58			
						RT-4	4.3			
	*Withania riebeckii*Schweinf	U'beb	Soqotra	Leaves, Fruit	Methanol	5637	0.8	MP	nd	[54]
						A-427	0.39			
						LCLC-103H	0.83			
						MCF-7	0.29			
						RT-4	3.78			
	*Withania somnifera*Dun.	U'beb	Hodeidah	Leaves	Ethanol	FL	12	NRU	Burns, Ear pain, wound healing	[32]
			Lahaj		Methanol	ECV-304	1.1	MTT		[17]
					Petroleum ether/ethylacetate (1:1) extrac		2			
Tiliaceae	*Corchorus erodioides*Balf. F.	Ezrab	Soqotra	Leaves, Flower	Methanol	5637	>50	MP	Diuretic and urinary tract infections	[55]
						A-427	>50			
						MCF-7	>50			
	*Grewia erythraea*Schweinf.	Shawhat, Khodar	d.l.Y	Leaves, Stem	Methanol	5637	>50	MP	Diuretic and for kidney diseases and haemostatic	[9]
						A-427	>50			
						MCF-7	>50			
Urticaceae	*Forsskaolea tinacissima*L.	Sobeet	d.l.Y	Leaves	Hot aqueous	FL	>1000	NRU	Diuretic and kidney diseases	[6]
							100			
			Yemen and Saudi Arabia	Leaves, Stem	Methanol	MRC-5	>64	nd		[52]
Verbenaceae	*Lantana camara*L.	Hashaf, Lanta	Sana'a	Fresh leave	Essential Oil	3T3	0.01	MTT	nd	[27]
						CE Mss	0.0031			

		na		s		CHO	0.025			
						HeLa	0.008			
						MCF-7	0.006			
						MDA-MB 231	0.006			
						WEHI-3B	0.0068			
	*Lippia citriodora*Kunth	nd	d.l.Y	Leaves	Hot aqueous	FL	>1000	NRU	Spasmolytic, gastrointestinal troubles, common cold and sedative	[6]
					Methanol		30			
Vitaceae	*Cissus quadrangularis*L.	Sala`a, Atroot	d.l.Y	Leaves, Stem	Methanol	5637	>250	NRU	Malaria, liver diseases and otitis	[7]
					Aqueous		>500			
					Aqueous	MCF-7	>500			
					Methanol		>250			
	Cissus rotundifolia(Forssk.) Vahl	Halas, Alfaq	d.l.Y	Leaves, Stem	Methanol	5637	242	NRU	Malaria, liver diseases and otitis	[7]
					Aqueous		>500			
					Aqueous	MCF-7	>500			
					Methanol		>250			
			Hajjah	Leaves	Methanol	FL	900			[18]
			Yemen and Saudi Arabia		Methanol	MRC-5	>64	nd		[52]
Zingiberaceae	*Costus arabicus*L.	Qist Arabi	d.l.Y	Root	Methanol	5637	19.2	MP	For cancers	[9]
						A-427	18.3			
						MCF-7	17.7			
	Curcuma Longa L.	Horod	Al Mahweet	Rhizomes	Acetone	A-431	25.4	MTT	nd	[45]
					Aqueous		25.9			
					Crude		179			
					Curcumin		4.68			
					Ethanol		29.1			
					Ethyl acetate		13.7			
					Petroleum ether		50.3			
					Acetone	A-549	22.5			
					Aqueous		17.4			
					Crude		103.5			
					Curcumin		3.23			
					Ethanol		21.7			
					Ethyl acetate		7.27			
					Petroleum ether		30			
					Acetone	WI-38	39.9			
					Aqueous		45.3			
					Crude		230			
					Curcumin		12.1			
					Ethanol		60.7			
					Ethyl acetate		19.8			

					Petroleum ether		**92.4**			
Zygophyllaceae	***Fagonia indica*Burm. F.**	**Shaka`h, Hilwah**	**d.l.Y**	**Leaves, Fruit**	**Methanol**	**5637**	**240**	**NRU**	**Diabetes, diuretic and headache**	[7]
					Aqueous	**5637**	**>500**			
						MCF-7	**>500**			
					Methanol	**MCF-7**	**>250**			
			Yemen and Saudi Arabia			**MRC-5**	**>64**	**nd**		[52]
	***Fagonia luntii* Baker**	**Hell**	**Abyan - Lawder**	**whole parts**	**Methanol**	**FL**	**490**	**NRU**	**Antiseptic, burns**	[18]
	***Peganum harmala*L.**	**Harmal**	**d.l.Y**	**Leaves, Fruit**	**Methanol**	**5637**	**>250**	**NRU**	**Malaria, worms, common colds, rheumatism and haemostatic**	[7]
					Aqueous		**>500**			
						MCF-7	**>500**			
					Methanol		**>250**			
			Hodeidah	**Aerial parts**	**Ethanol**	**FL**	**155**		**Urolithiasis, dysuria**	[32]
	***Tribulus terrestris*L.**	**Qutiba**	**Sana'a**	**Leaves**	**Ethanol**	**FL**	**22**	**NRU**	**Fever**	[32]

Abbreviations of Cytotoxicity assays: -CCK-8 assay (Cell Counting Kit-8 assay); **CV assay** (cell viability assay); **CVS assay** (Crystal Violet Staining Assay); **MP assay** (Microtiter plate assay); **MTT assay** (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-2H-tetrazolium bromide assay); **nd** (not determined); **NRU assay** (neutral red uptake assay); **SRB assay**Sulforhodamine B; **XTT assay** (2,3-bis-(2-methoxy-4-nitro-5-sulfophenyl)-2H-tetrazolium-5-carboxanilide (XTT)-assay)

Abbreviations of Cancer cell line type:- A-431 (skin cancer); **3T3** (mouse fibroblast cell lines); **5637** (urinary bladder cancer); **A-427** (lung cancer); **A-549** (lung adenocarcinoma); **AGS** (gastric cancer); **Bj-1** (human normal immortalized skin fibroblasts); **CACO** (intestinal cancer); **CACO-2** (colorectal adenocarcinoma); **CEMss** (T4-lymphoplastoid); **CHO** (Chinese hamster ovary); **ECV-304** (human bladder carcinoma); **FL-cell** (human amniotic epithelial); **H103** (Human oral squamous cell carcinoma, tongue); **H314** (Human oral squamous cell carcinoma, floor of mouth); **H357** (Human oral squamous cell carcinoma, tongue); **H376** (Human oral squamous cell carcinoma, floor of mouth); **H400** (Human oral squamous cell carcinoma, alveolar process); **H413** (Human oral squamous cell carcinoma, buccal mucosa); **HCT-116** (human colon adenocarcinoma); **HDFa** (dermal fibroblasts cell line); **HELa** (cervical cancer); **HeP2** (Colorectal carcinoma); **HepG-2** (Hepatocellular carcinoma); **HL-60** (human promyelocytic leukaemia); **HSF** (Human skin fibroblast); **HT29** (Human colonic adenocarcinoma cells); **HUVEC** (normal human umbilical vein endothelial cells); **LCLC-103H** (lung cancer); **MCF10A** (human mammary epithelial cell line); **MCF-7** (breast cancer); **MDA-MB 231** (human mammary cancer cell linesestrogen negative); **MNFS-60** (myelogenous leukaemia); **MRC-5** (human foetal lung fibroblast cells); **PC-3** (prostate cancer); **RD** (Rhabdomyosarcoma); **RT-4** (urinary bladder cancer); **SW480** (Human colorectal cancer cell lines); **WEHI-3** (murine myelomonocytic leukaemia); **WI-38** (Normal cell line); **WRL68** (human hepatic cell line)

Other Abbreviations: - d.l.Y(different localities on Yemen)

4. Discussion

This review summarized different studies on the effectiveness of Yemeni medicinal plants on numerous cancer cell lines. The studies were conducted on different plants collected from several localities of Yemen, which means a wide geographical and climatic diversity. This fact results in different activities of the same plant collected from several places on the same cancer cell line or on others. For example, it was found that *Chenopodium ambrosioides* plant collected from Sana'a governorate has high activity with IC_{50} of 0.021 µg/mL against MCF-7 cancer cell line while the same plant has less effectiveness when it was collected from another locality. This result confirms studies indicating that climate and environmental factors affect the quality of active compounds, and therefore further studies must be done to compare the effectiveness of plants collected from several localities.

In addition, there are different reported activities of the same plant on the different cancer cell lines. For example, it was found that *n-heptane* extract of *Acalypha fruticose* aerial parts collected from Al-Mahweet governorate has high activity with IC_{50} of 10.1 and 15.4 µg/mL on HCT-116 and HePG-2 cancer cell line, respectively.While the same extract has less activity on MCF-7 and MRC-5 cell lines with IC_{50} of 23.1 and 85.2 µg/mL. On the other hand, other studies fall short in examining the activity of plant on only one cell line.Leaves and seeds of *Gossypium areysiamum* collected from two region has IC_{50}>1000 µg/mL on FL cell lines but there are no studies on another cell lines.Thus, further studies including other cell lines are highly recommended to compare the effectiveness of each Yemeni plant on different cell lines.

Despite the high cytotoxic activities of many Yemeni plants on cancer cell lines, few compounds (only seven compounds) have been isolated and examined for their cytotoxic activity. Therefore, great efforts are required from researchers in the future to isolate the active compounds and study their effects on various cancer cell lines to reach an effective and safe medicine with known mechanism of action.

Regarding the type of extractsused in the reported experiments, obvious variations in the activity of medicinal plants were observed. For example, chloroform and *n-heptane* extract of *Acalypha fruticose* aerial parts collected from Al-Mahweet governorate has high activity with IC_{50} of 4.81 and 10.1 µg/mLon HCT-116 while the Ethyl acetate and *n-butanol* extract showed less activity on the same cell lines with IC_{50} > 100 µg/ml, due to different chemical content for each extract from the same plants.

Moreover, Methanolic extract of *Capparis cartilaginea* collected from Amran- AL-Madan showed different activities on A-549 cell lines based on plant part used, leaves showed IC_{50}>1000 µg/mL, while stem showed IC_{50} (240 µg/mL), and twigs showed IC_{50} (57.5 µg/mL). Therefore, different plant parts must be taken into account when studying cytotoxic effect.

Only one study that formulated a dosage form plant extract and examined the product's impact on cancer cell lines using data from an earlier investigation of El-Shaibany et al[43]. Different*Dictyota dichotoma* extracts (*i.e.*aqueous, methanol, chloroform, ethyl acetate, *n-butanol*, and petroleum ether) were taken from Hodeida City's seacoasts and showed high and moderate cytotoxicity on various cancer cell line]43[. In a subsequent investigation conducted in collaboration with professor Alburyhi, six formulations of *D. dichotoma* extract capsules were designed, and their activity was studied[63].

Finally, although the Yemeni flora is rich in medicinal plants comprising about 2838 species, our results included approximately only 9% of the Yemeni plant species for various cytotoxicity studies.This means that there are approximately 90% of Yemeni plants are not well investigated yet. Therefore, more effortsare needed to conduct more studies including other plant species to investigatetheir effect on different cancer cell lines.

5. Conclusion

In the current review, 52 reportson the cytotoxic activity of Yemeni medicinal plants on different cancer cell lines, were represented. 1083 IC_{50}values against forty-four cancer cell lines.Using different extracts viz., essential oils, aqueous, alcoholic and other organic extracts, as well as isolated compounds.Studies were conducted on 229 species, belonging to 163 genera and 72 families collected from several localities in Yemen. The review found that, 313 out of 1083 results for extracts were with an IC_{50}values less than 20 µg/mLthat can be considered aspotent cytotoxic, also 491 plant extracts with an IC_{50} of 21–200 µg/mL are considered moderately cytotoxic, and 96 extracts with an IC_{50} of 201–500 µg/mL (weakly cytotoxic) according to classification of the National Cancer Institute and Geran protocol[60].

Few data were available on effects of these extracts on normal cell lines, so, it is highly recommended to include it in future works.

As a conclusion, Yemeni medicinal plants are considered as a valuable source of medicines for treating cancers. Further great efforts in future from researchers and specialized authorities are to be established to finance and conduct research projects to evaluate the effectiveness of different Yemeni plants collected from several diverse environmental regions on several cancer cell.

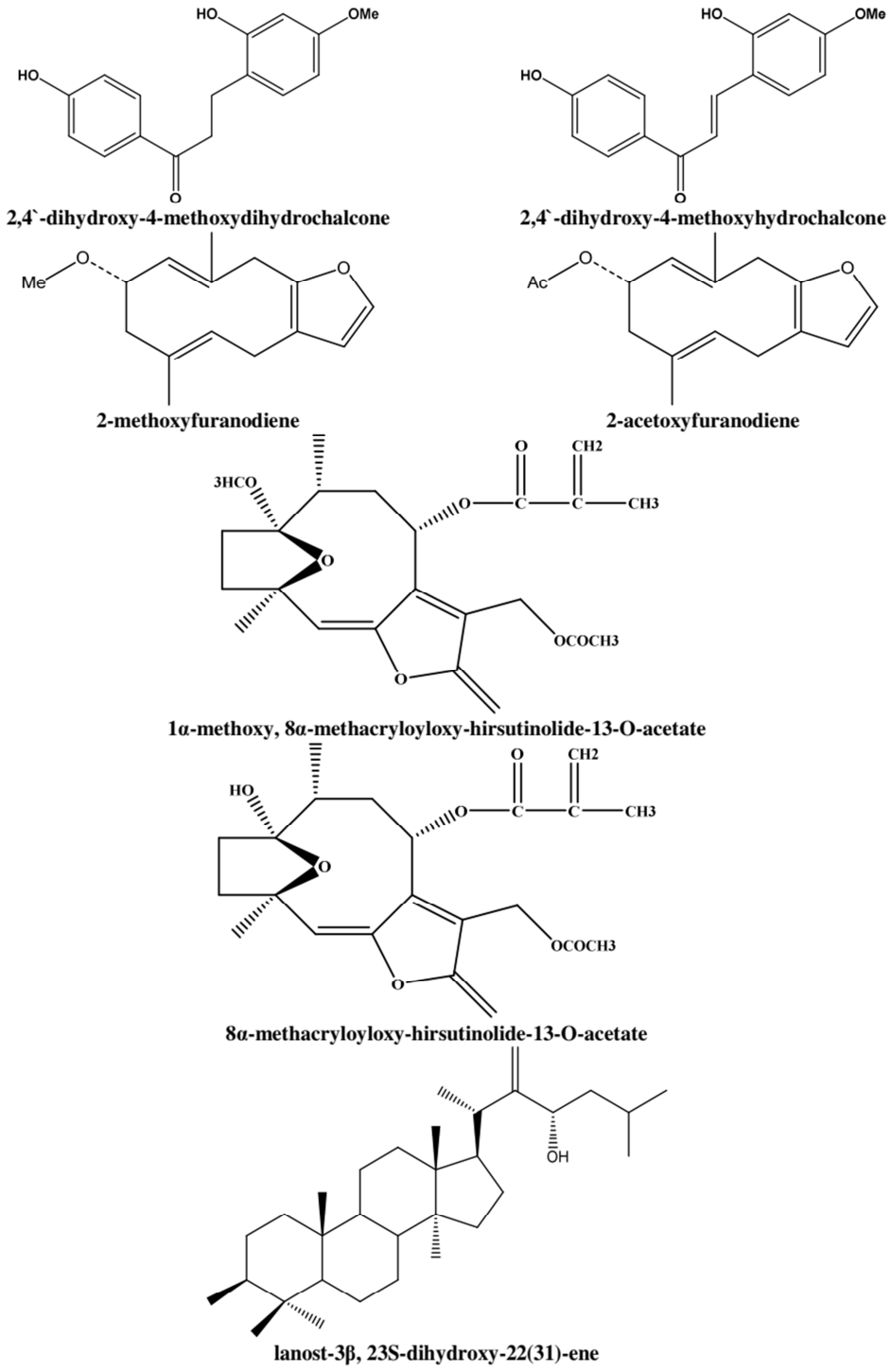

Figure 3: Structures of isolated compounds with cytotoxic effect [39, 48, 53]

6. Future prospective

The current review adds value to all researchers looking for information regarding the Yemeni medicinal plants that act as anticancer drugs. The review sheds lights on the effect of Yemeni plants on different cancer cell lines and their various locations in the Yemeni governorates. This information facilitates reaching these plants at their localities aiming to conduct further studies on plants mentioned in this review that showed high effectiveness against cancer cell lines. In addition to initiate studies on other plants that not mentioned in these studies but shares same genus or active constituents. Moreover, most of the reported data on these plants lacks identifying the chemical constituents responsible for the activity and its mechanism of action which warrants for directing all upcoming research to cover this point. Also, taking into consideration the geographical diversity and its effect on the chemical compounds produced in plants, further research can be carried out on comparing activity of plants from different localities to study their effects on cancer cell lines as well,

Table (2): Plant Families Included in the Review

No.	Family	Frequency	Percent	No.	Family	Frequency	Percent
1	Acanthaceae	24	2.2	37	Fabaceae (Mimosaceae)	16	1.5
2	Amaranthaceae	6	0.6	38	Gentianaceae	8	0.7
3	Anacardiaceae	17	1.6	39	Hydnoraceae	3	0.3
4	Apiaceae (Umbelliferae)	7	0.6	40	Iridaceae	2	0.2
5	Apocynaceae (Asclepiadaceae)	36	3.3	41	Lamiaceae (Labiatae)	113	10.4
6	Aristolochiaceae	4	0.4	42	Liliaceae	3	0.3
7	Asphodelaceae (Aloeacea)	79	7.3	43	Loganiaceae	8	0.7
8	Asteraceae (Compositae)	124	11.4	44	Loranthaceae	6	0.6
9	basidiomycetes-Agaricaceae	12	1.1	45	Lythraceae	3	0.3
10	basidiomycetes-Amanitaceae	1	0.1	46	Malpighiaceae	10	0.9
11	basidiomycetes-Anacardiaceae	1	0.1	47	Malvaceae	6	0.6
12	basidiomycetes-Fomitopsidaceae	1	0.1	48	Meliaceae	5	0.5
13	basidiomycetes-Ganodermataceae	2	0.2	49	Moraceae	18	1.7
14	basidiomycetes-Hymenochaetaceae	2	0.2	50	Myrtaceae	15	1.4
15	basidiomycetes-Phelloriniaceae	1	0.1	51	Oxalidaceae	6	0.6
16	basidiomycetes-Pluteaceae	1	0.1	52	Pandanaceae	1	0.1
17	basidiomycetes-Polyporaceae	2	0.2	53	Piperaceae	24	2.2
18	Bignoniaceae	5	0.5	54	Plumbaginaceae	15	1.4
19	Boraginaceae	7	0.6	55	Polygonaceae	1	0.1
20	Brassicaceae	2	0.2	56	Pteridophyta	2	0.2
21	Burseraceae	54	5.0	57	Punicaceae	6	0.6
22	Buxaceae	5	0.5	58	Ranunculaceae	3	0.3
23	Cactaceae	1	0.1	59	Resedaceae	8	0.7
24	Caesalpiniaceae	1	0.1	60	Rhamnaceae	5	0.5
25	Capparaceae (Cleomaceae)	36	3.3	61	Rubiaceae	5	0.5
26	Caricaceae	1	0.1	62	Salicaceae	4	0.4
27	Caryophyllaceae	8	0.7	63	Salvadoraceae	9	0.8
28	Chenopodiaceae	11	1.0	64	Sapindaceae	2	0.2
29	Commelinaceae	4	0.4	65	Scrophulariaceae	11	1.0
30	Crassulaceae	5	0.5	66	Solanaceae	27	2.5
31	Cucurbitaceae	27	2.5	67	Tiliaceae	6	0.6
32	Cupressaceae	3	0.3	68	Urticaceae	3	0.3
33	Dictyotaceae	42	3.9	69	Verbenaceae	9	0.8
34	Dracaenaceae (Agavaceae)	19	1.8	70	Vitaceae	10	0.9
35	Ebenaceae	10	0.9	71	Zingiberaceae	24	2.2
36	Euphorbiaceae	113	10.4	72	Zygophyllaceae	12	1.1
					Total	1083	100.0%

7. Conflicts of interest
There are no conflicts to declare

8. Formatting of funding sources
None

9. Acknowledgments
None

10. References

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