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Review article/Derleme

The potential benefits of medicinal and aromatic plants in cancer patients undergoing radiotherapy

Faruk KARAHAN [*1], Ahmet İLÇIM [1]

[1] Mustafa Kemal Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, 31100, Hatay, Turkey

Abstract

Cancer is a complex and important disease that leading cause of death worldwide. Genetic asset, environmental pollution, dietary habit and infections are the major causes concurring to cancer. Radiotherapy (RT) is the most common method in cancer therapy. However, radiotherapy induces some side effect in human body. The most common side effects of radiotherapy are weight loss, fatigue, diarrhoea, pain, sleep disorders, appetite loss, nausea, vomiting, skin reactions and oral complications. Recent clinical and pharmacologic research show that good dietary and plant secondary metabolites/multivitamin remove to side effect in cancer patients during or after radiotherapy. Our study identified 66 medicinal and aromatic plants, spanning a total of 20 medicinal purpose categories. Most commonly used plants as follows: *Allium sativum* L. (garlic), *Juglans regia* L. (walnut) and *Solanum lycopersicum* L. (tomatoes) for medicinal purposes. This paper is an overview of important of nutrition activity and herbal products for help to remove side effects of radiotherapy (RT) in cancer patients.

Key words: cancer, radiotherapy, side effect, ethnobotany

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Radioterapi gören kanser hastalarinda tibbi ve aromatik bitkilerin potansiyel faydaları

Özet

Kanser, dünya çapında en fazla ölüme neden olan kompleks bir hastalıktır. Genetik yatkınlık, çevre kirliliği, beslenme alışkanlığı ve enfeksiyonlar kansere neden olan başlıca etkenlerdir. Kanser tedavisinde kullanılan en yaygın yöntem radyoterapidir (RT). Bununla birlikte, radyoterapi insan vücudunda bazı yan etkilere yol açar. Radyoterapinin en yaygın yan etkileri kaşeksi, kilo kaybı, yorgunluk, ishal, ağrı, uyku bozuklukları, iştah kaybı, mide bulantısı, kusma, cilt reaksiyonları ve oral komplikasyonlardır. Yeni klinik ve farmakolojik araştırmalarla iyi bir diyet ve bitki sekonder metabolitleri desteğiyle kanser hastalarında radyoterapi sırasında veya sonrasında meydana gelen yan etkilerin giderildiği görülmüştür. Çalışmamızda radioterapinin 20 yan etkisine karşı kullanım potansiyeli olan 66 tıbbi ve aromatik bitki belirlenmiştir. *Allium sativum* L. (sarımsak), *Juglans regia* L. (ceviz) ve *Solanum lycopersicum* L. (domates) tıbbi ve aromatik açıdan radyoterapi kaynaklı yan etkilere karşı kullanılan en yaygın bitkilerdir. Bu derleme, kanser hastalarında radyoterapinin (RT) yan etkilerinin ortadan kaldırılmasına yardımcı olan beslenme faaliyetlerinin ve bitkisel ürünlerin önemini belirtmektedir.

Anahtar kelimeler: kanser, radioterapi, yan etki, etnobotanik

1. Introduction

Cancer is one of the important public health problems in many developed or developing countries since ancient time (Wu et al., 2006). It affects all people including the children, young or old, the rich and poor, men and women. The World Health Organization (WHO) reports that every year there are approximately 38 million new cases of noncommunicable diseases (NCD) with cancer representing the second cause of NCD with 8.2 million deaths, corresponding to 22% of all NCD in 2012 (Stewart and Wild, 2015). That's more than the percentage of deaths caused by HIV/AIDS, tuberculosis, and malaria put together. Worryingly, these trends are being mirrored globally, and the

[*] *Corresponding author* / Haberleşmeden sorumlu yazar: Tel.: +905073747450; Fax.: +905073747450; E-mail: : farukkarahan34@gmail.com

number of people dying of cancer worldwide is expected to increase from 8.2 million in 2012 to 14.6 million in 2035 and the global costs of cancer are estimated to rise to 458 billion (Arteaga et al., 2014). There are nearly 200 known types of cancer. Lung (1.59 million deaths), liver (745.000 deaths), stomach (723.000 deaths), colorectal (694 000 deaths), breast (521.000 deaths), oesophageal cancer (400.000 deaths) and leukemia (265.000) are the most common causes of cancer death worldwide, accounting for nearly half of all cancer deaths (Stewart and Wild, 2015; Torre et al., 2015).

Cancer is treated by surgery, radiotherapy, chemotherapy, hormones, immunotherapy, targeted therapy, gene therapy, hemopoietic and peripheral blood stem cell transplantation (Mimeault and Batra, 2008; Wu et al., 2006). Currently, radiotherapy (RT) is most commonly method in cancer therapy since very early after the discovery of X-rays and provides cure or palliative care for approximately 50% of the cancer cases (Chen et al., 2004; Delaney et al., 2005). It uses high-energy particles or waves, such as x-rays, gamma rays, electron beams, or protons, to destroy or damage cancer cells (Mourou and Umstadter, 2002). However, many reports claim that radiotherapy causes direct or indirect side effects such as cardiovascular disease, cataract, hair loss, cachexia, weight loss, fatigue, diarrhea, constipation, pain, swallowing difficulty, sleep disorders, anorexia, nausea, decreased blood counts, vomiting, skin reactions and oral complications (Ahlberg et al., 2005; Bansal et al., 2004; Çavuşoğlu et al., 2008; Epstein et al., 1999; Güleser et al., 2012; Irvine et al., 1998; Senkus-Konefka and Jassem, 2007; Visser and Smets, 1998). The side effects of radiation therapy depend on the area irradiated, total dose, fractionation, duration, and volume irradiated (Trotti et al., 2000; Withers et al., 1995). Most side effects are acute, begin around the second or third week of treatment, and diminish 2 or 3 weeks after radiation therapy is completed. Some side effects can be chronic and continue or occur after treatment has been completed (Donaldson, 1977). Recent clinical and pharmacologic research show that good dietary and plant secondary metabolites/multivitamin can remove to side effect in cancer patients during or after radiotherapy. The purpose of this literature review is contribute to data about potential benefits of good nutrition activities and herbal products for help to tolerate the side effects of radiotherapy (RT) in cancer patients.

2. Materials and methods

The present study, the following databases were searched up to April 2016: Web of Science, PubMed, Medline, and the Cochrane Library. The search terms and key words included “radiotherapy” OR “cancer therapy” OR “cancer patients” AND “side effects” OR “nutrition support” OR “good dietary activity” OR “medicinal and aromatic plants” OR “nutrition activity” OR “herbal products” OR “remove to side effects”. The aim was to select all reports, whether previously research side effects of radiotherapy and reviews relative to the remove potential benefits of medicinal and aromatical plants in remove to side effects of radiotherapy.

3. Results

A total of 66 plant taxa belonging to 34 families with medicinal and aromatic values are alphabetically listed with their botanical name, part used, preparations used and ailment treated. The families with the highest number of taxa are Rosaceae (7), Brassicaceae, Rutaceae (5 each) and Fabaceae (4), whereas the genera with the highest number of taxa are *Citrus* (5), *Brassica* (4) and *Cucurbita*, *Prunus* (3 each). Most commonly used plants as follows: *Allium sativum* L. (garlic), *Juglans regia* L. (walnut) and *Solanum lycopersicum* L. (tomatoes) for treatment to side effects of radiotherapy in cancer patients (Table 1).

Table 1. Medicinal and aromatical plants for help to remove side effects of RT (*: Natural; **: Culture form; *,**: Natural and Culture forms).

No	Family/Taxa	English Name	Part used	Preparation	Medicinal purpose
	ACTINIDIACEAE				
1	**Actinidia deliciosa* 'Cultivar'	Kiwifruit	Fruits	Eaten fresh, used mashed massage gel	Tissue repair, skin wounds (Hafezi et al., 2010), oxidative stres, constipation (Park et al., 2006; Parkar et al., 2010)
	ALLIACEAE				
2	**Allium cepa* L.	Onion	Bulb, leaves	Eaten fresh, cooked, drunk as tea, decoction	Cataract, skin reactions, oral mucositis, inflammation, cardiovascular disease (Raju et al., 2008), oxidative stress, headache (Corzo-Martínez et al., 2007)
3	**Allium sativum* L.	Garlic	Bulb, leaves	Eaten fresh or cooked, drunk as tea, decoction	Cataract (Raju et al., 2008), skin reactions, oxidative stress, oral mucositis, inflammation, fatigue,

					helps to increase the blood flow (Corzo-Martínez et al., 2007), constipation (Gupta et al., 2014), hair loss (Hajheydari et al., 2007)
	AMARANTHACEAE				
4	**Spinacia oleracea* L.	Spinach	Leaves	Eaten cooked and boiled, used as salve	Source of Omega-3 (Kapoor and Patil, 2011), tissue repair, oxidative stress, constipation, sleep disorders (Bergquist et al., 2005), fatigue, cardiovascular system, skin reactions (Bhatia and Jain, 2004)
	ANACARDIACEAE				
5	**Mangifera indica* L.	Mango	Fruits	Eaten fresh, cooked or mixed with honey	Oxidative stress, tissue repair (Martinez et al., 2000), blood pressure (Beltrán et al., 2004), fatigue, diarrhea (Olowa et al., 2012), inflammatuar (Garrido et al., 2001)
	APIACEAE				
6	**Daucus carota* L.	Carrot	Roots	Drunk as juice, Eaten fresh as salad, cooked	Oxidative stress, tissue repair, cardiovascular disease (Sant'Ana et al., 1998) cataract, constipation, skin reactions (Breithaupt and Bamedi, 2001)
	ARECACEAE				
7	**Phoenix dactylifera* L.	Date palm	Pollen, Fruits	Eaten fresh or maceration	Oral mucositis, blood pressure, help to increase the erythrocyte count (Elkerm and Tawashi, 2014), cataract, constipation, oxidative stress (Mansouri et al., 2005), fatigue, cardiovascular disease (Baliga et al., 2011)
	ASPARAGACEAE				
8	***Yucca schidigera* L.	Yucca	Aerial parts	Drunk as juice, used as massage gel	Hair loss, pain, headache (Patel, 2012), oxidative stress, inflammation, blood pressure (Zubair et al., 2013)
	ASPHODELACEAE				
9	***Aloe vera* L.	Aloe vera	Leaves	Massage gel/extraction or maceration	Radiation burn, wounds, inflammation (Shamim et al., 2004)
	ASTERACEAE				
10	***Anthemis nobilis* L.	Chamomile	Flowers	Used as massage gel infusion form	Hair loss (Akbulut and Bayramoglu, 2013)
11	***Bellis perennis* L.	Common daisy	Flowers	Garnish or additive in cakes, sandwiches, soups and salads or drink infusion form	Diarrhea, headache, skin burns (Çakılcıoğlu et al., 2010; Uzun et al., 2004), oxidative stress (Kavalcioğlu et al., 2010; Li et al., 2005)
12	**Lactuca sativa* L.	Lettuce	Leaves	Eaten as salad	Tissue repair, oxidative stress, (Chu et al., 2002)
	BRASSICACEAE				
13	**Brassica oleracea* 'Botrytis'	Cauli flower	Flowers	Eaten fresh, cooked, fried, boiled	Source of Omega-3 (Kapoor and Patil, 2011), inflammation, oxidative stress (Sultana and Anwar, 2008)
14	**Brassica oleracea*	Kale	Leaves	Eaten fresh, cooked	Source of Omega-3 (Kapoor and Patil, 2011), oxidative stress (Sultana and Anwar, 2008)
15	**Brassica oleracea* 'Italica'	Broccoli	Leaves	Eaten cooked	Source of Omega-3 (Kapoor and Patil, 2011), tissue repair, oxidative stress (Sultana and Anwar, 2008)
16	**Brassica oleracea*	Brussels sprouts	Leaves	Eaten fresh or	Source of Omega-3 (Kapoor and

	'Gemmifera'			cooked	Patil, 2011), inflammation, oxidative stress (Sultana and Anwar, 2008)
17	**Raphanus sativus* L.	Radish	Bumps seeds	Eaten fresh as salads, drunk as juice, seeds grind and mixed with salt	Anorexia (Phondani et al., 2010)
	BROMELIACEAE				
18	**Ananas comosus* (L.) Merr.	Ananas	Fruits	Eaten fresh and drunk as juice	Inflammation, wound healing (Pieters et al., 2007), regulate to blood count, blood pressure (Taussig and Batkin, 1988)
	CAPPARACEAE				
19	***Capparis spinosa* L.	Caper	Buds, fruits	Eaten canned and pickled as a garnish, decoction	Diarrhea (Ugulu et al., 2009), cataract, skin reactions, oxidative stress, inflammation (Kheirollah et al., 2015) help to increase blood cells counts (Huseini et al., 2005).
	CARICACEAE				
20	**Carica papaya* L.	Papaya	Fruits leaves	Drunk as juice, eaten as breakfast, and as ingredients in jellies, jam, or cooked as vegetable	Oxidative stress, tissue repair (Krishna et al., 2008; Wall, 2006)
	CONVOLVULACEAE				
21	**Ipomoea batatas* L.	Sweet potato	Tuber	Eaten fresh, cooked and cubed	Cataract, inflammation (Aruoma, 1998), oxidative stress, cardiovascular disease, immune system (Huang et al., 2004)
	CUCURBITACEAE				
22	**Cucurbita pepo* L.	Squash	Fruits	Eaten cooked	Tissue repair, oxidative stress (Mongkolsilp et al., 2004)
23	**Cucurbita moschata* Duchesne ex Poir.	Pumpkins	Fruits seeds	Eaten cooked as a vegetable or sweet	Tissue repair, oxidative stress, inflammation (Yadav et al., 2010)
24	**Cucurbita maxima* Duchesne	Winter squash	Fruits	Eaten cooked or sweet	Source of Omega-3 (Kapoor and Patil, 2011), inflammation (Yadav et al., 2010)
	ELAEAGNACEAE				
25	***Hippophae rhamnides* L.	Sea-buckthorn	Fruits	Eaten as fresh, shurub, jam and infusion	Oxidative stress, cardiovascular disease, inflammation, skin reactions (Zeb, 2004)
	ERICACEAE				
26	*/***Cornus mas* L.	Cornelian cherry	Fruits	Eaten fresh or marmelade and drunk as sherbet and juice	Oxidative stress, cardiovascular disease, inflammation (Gülçin et al., 2005), constipation (Dulger and Gonuz, 2004), skin reaction, weight loss, tissue repair, help to increase the blood count (Eshaghi et al., 2012)
27	***Vaccinium myrtillus* L.	Bilberry	Fruits leaves	Eaten fresh or as marmelade and drunk as juice and tea.	Cataract (Zafra-Stone et al., 2007), helps to increase the blood flow, cardiovascular disease, oxidative stress, tissue repair, inflammation (Faria et al., 2005), bladder and urinary disease (Head, 2008)
	FABACEAE				
28	**Arachis hypogaea* L.	Peanut	Seeds	Eaten fresh, cooked, dried, extraction oil	Help to increase the thrombocyte and leucocyte count, oxidative stress (Martín et al., 2006)
29	**Glycine max* (L.) Merr.	Soybean	Fruits	Eaten cooked, drink sauce, gel/Extraction	Source of Omega-3 (Kapoor and Patil, 2011), anorexia, helps to increase the blood flow, inflammation, skin reaction (Phondani et al., 2010)

30	***Glycyrrhiza glabra* L.	Licorice	Roots stolon	Added as licorice honey, drunk as sherbet and tea maceration, infusion	Oxidative stress (Shetty et al., 2002), inflammation (Yokota et al., 1998)
31	**Pisum sativum* L.	Pea	Fruits	Eaten cooked	Tissue repair, oxidative stress (Troszyńska et al., 2002)
	GINKGOACEAE				
32	***Ginkgo biloba* L.	Ginkgo biloba	Leaves	Extraction	Cataract, oxidative stress, headache (Ertekin et al., 2004)**,** fatigue (Lovera et al., 2007)**,** cardiovascular disease, skin infections (Sharma and Agarwal)
	GROSSULARIACEAE				
33	***Ribes uva-crispa* L.	Gooseberry	Fruits	Eaten as fresh and dried	Oxidative stress (Kähkönen et al., 2001)
	HYPERICACEAE				
34	***Hypericum perforatum* L.	St. John's Wort	Flowers	Massage gel or drunk as tea decoction and infusion	Oxidative stress, sleep disorders (Sharma and Agarwal, 2011) pain, skin burns, inflammation and wounds (Greeson et al., 2001), diarrhea (Karliova et al., 2000), laxative (Ugulu et al., 2009)
	JUGLANDACEAE				
35	**Juglans regia* L.	Walnuts, butternut	Seeds, leaves	Drunk, eaten fresh, cooked, dried, massage using extraction oil, decoction using leaves	Source of Omega-3 (Kapoor and Patil, 2011), constipation, skin reactions, oral mucositis (Siegel et al., 2016), anorexia, weight loss, fatigue, oxidative stress, inflammation (Zhang et al., 2009),
	LAMIACEAE				
36	**Mentha* L.	Mint	Leaves	Used as spice, drunk as tea, mixed with lemon in hot water	Cataract, cardiovascular disease, inflammation (Zekri et al., 2013), oxidative stress, nausea and vomiting, anorexia, headache, muscular pains, skin reactions (Shah and Mello, 2004), diarrhea (Atta and Mouneir, 2004)
37	***Ocimum basilicum* L.	Basil	Leaves seeds,	Drink tea infusyon	Depression, laxative (Ugulu et al., 2009)
	LINACEAE				
38	***Linum usitatissimum* L.	Flax Seed	Seeds	Use powdered and mixed with honey, yogurt and salads, flaxoil	Source of Omega-3 (Kapoor and Patil, 2011), oxidative stress, tissue repair, inflammation (Touré and Xueming, 2010)
	MALVACEAE				
39	***Althaea officinalis* L.	Marsh-mallow	leaves	Drunk infusion	Oral mucositis (Ugulu et al., 2009)
	MORACEAE				
40	**Morus* L.	Mulberry	Fruits	Drunk as juice, eaten fresh, shurub and pekmez	Help to increase the thrombocyte and leucocyte count (Martín et al., 2006), oxidative stress, tissue repair (Sohn et al., 2004), oral mucositis (Ugulu et al., 2009)
	MUSACEAE				
41	**Musa* L.	Bananas	Fruits	Juice and eaten fresh or with mix honey	Diarrhea, blood pressure, fatigue,cardiovascular disease (Kumar and Bhowmik, 2012)
	MYRTACEAE				
42	**Psidium guajava* L.	Guava	Fruits	Drunk as juice or eaten	Oxidative stress (Mondal et al., 2009)
43	**Syzygium aromaticum* L.	Cloves	Buds	Dried, ground, infusion	Source of Omega-3 (Kapoor and Patil, 2011), diarrhea (Ugulu et al.,

					2009), oral mucositis, oxidative stress (Chaieb et al., 2007)
	OLEACEAE				
44	**Olea europaea* L.	Olive	Fruits seeds	Eaten fresh, add to salad olive oil and used as soap	Source of Omega-3 (Kapoor and Patil, 2011), oxidative stress, cardiovascular disease, tissue repair, inflammation, skin reactions (El Sedef and Karakaya, 2009), helps to blood pressure (Somova et al., 2003)
	POACEAE				
45	**Zea mays* L.	Corn	Fruits	Eaten boiled and cooked	Oxidative stres, inflammation, skin reactions, helps to increase the blood flow (Liu et al., 2011; Rahmatullah et al., 2010)
	POLYGONACEAE				
46	***Reynoutria japonica* Sieb. and Zucc.	Japanese knotweed	Root stem	Extraction	Oxidative stress (Martín et al., 2006), inflammation, help to increase the blood count (Beňová et al., 2010)
	ROSACEAE				
47	**Fragaria* sp.	Berry	Fruits	Drunk as juice or eaten	Tissue repair, source of Omega-3 (Kapoor and Patil, 2011)
48	**Malus domestica* 'Borkh'	Apple	Fruits	Drunk as juice or eaten fresh and apple sauce	Oxidative stress, cardiovascular disease, diarrhea (Hagen et al., 2007)
49	**Prunus* sp.	Plum	Fruits	Drunk as juice or eaten fresh	Oxidative stress, inflammations (Ballistreri et al., 2013)
50	**Prunus armeniaca* L.	Apricots	Fruits	Drunk as juice, eaten fresh or dried	Tissue repair, oxidative stress (Alasalvar and Shahidi, 2013)
51	**Prunus avium* L.	Cherry	Fruits	Drunk as juice, eaten fresh	Inflammation, oxidative stress help to increase the thrombocyte and leucocyte count (Alasalvar and Shahidi, 2013)
52	*/***Rosa* sp.	Rosa	Petals	Drunk as juice, infusion	Diarrhea, skin reactions, oral mucositis (Ugulu et al., 2009)
53	***Rubus idaeus* L.	Raspberry	Fruits leaves	Drunk as juice, decoction	Source of Omega-3 (Kapoor and Patil, 2011), help to increase the blood count, diarrhea, skin burns (Ugulu et al., 2009)
	RUTACEAE				
54	**Citrus sinensis*	Orange	Fruits	Drunk as juice, eaten fresh	Cataract (Jacques et al., 1997), cardiovascular disease, oxidative stress, tissue repair, inflammations (Economos and Clay, 1999)
55	**Citrus reticulata* 'Blanco'	Mandarin	Fruits	Drunk as juice, eaten fresh	Cataract (Jacques et al., 1997), oxidative stress, cardiovascular disease tissue repair, inflammations (Okwu and Emenike, 2006)
56	**Citrus paradisi*	Greyfurt	Fruits	Drunk as juice, eaten fresh	Cataract (Jacques et al., 1997), oxidative stress, cardiovascular disease tissue repair, inflammations (Economos and Clay, 1999)
57	**Citrus maxima*	Pomelo	Fruits	Drunk as juice, eaten fresh	Cataract (Jacques et al., 1997), oxidative stress, cardiovascular disease tissue repair, inflammations (Economos and Clay, 1999)
58	**Citrus limon*	Limon	Fruits	Drunk as juice, eaten fresh	Cataract (Jacques et al., 1997), oxidative stress, cardiovascular disease tissue repair, inflammations (Economos and Clay, 1999)

	SAPINDACEAE				
59	**Aesculus hippocastanum* L.	Horsechestnut	Fruits	Drunk as tea	Diarrhea (Ugulu et al., 2009)
	SOLANACEAE				
60	**Capsicum* sp.	Red Pepper	Fruits	Used as food or spice	Tissue repair, hormone regulators, anorexia, fatigue, oxidative stress (Halberstein and Saunders, 1978; Yousaf et al., 2006)
61	**Solanum lycopersicum* L.	Tomatoes	Fruits	Eaten fresh and cooked Drunk as juice	Oxidative stress, tissue repair, DNA damage, regulate to blood count, weight loss, cardiovascular disease(Preedy, 2008), skin reactions, inflammations (Zulueta et al., 2015)
62	**Solanum nigrum* L.	Black nightshade	Fruits, leaves	Used as mashed, massage gel	Oral mucositis (Patel et al., 2014), blood pressure (Yousaf et al., 2006), cardiovascular disease, skin reactions (Shamim et al., 2004)
	VITACEAE				
63	**Vitis* sp.	Grape	Fruits seeds	Eaten fruits, dried and pekmez, drunk as juice	Regulate to blood count, oxidative stress, tissue repair (Huang et al., 2005), DNA damage, weight loss, cardiovascular disease (Pawlus et al., 2012)
	ZINGIBERACEAE				
64	**Alpinia officinarum* Hance	Galangal	Roots	Drunk as tea infusion	Headache(Ugulu et al., 2009)
65	**Curcuma longa* L.	Turmeric	Roots	Used as cooking spice, tea, topically, orally, and by inhalation	Wounds, inflammations, oxidative stress (Chainani-Wu, 2003; Çıkrıkçı et al., 2008)
66	**Zingiber officinale* Roscoe	Ginger	Roots	Used as cooking spice, ginger bread, ginger snaps, ginger cake and ginger biscuits, mixed with honey, drunk as ginger juice and tea	Cataract, constipation, diarrhea, anorexia, nausea and vomiting, stomach pain (Malhotra and Singh, 2003; Malu et al., 2009)

A majority of these plants are cultivated form (72.73 per cent), followed by natural form (24.24 per cent) while *Rosa* and *Cornus mas* taxa are both natural and cultivated forms (3.03 per cent) (Table 1). Most widely used parts of the plants are fruits (45 per cent), followed by other parts (26.25 per cent), leaves (21.25) and roots (7.5 per cent) (Figure 1).

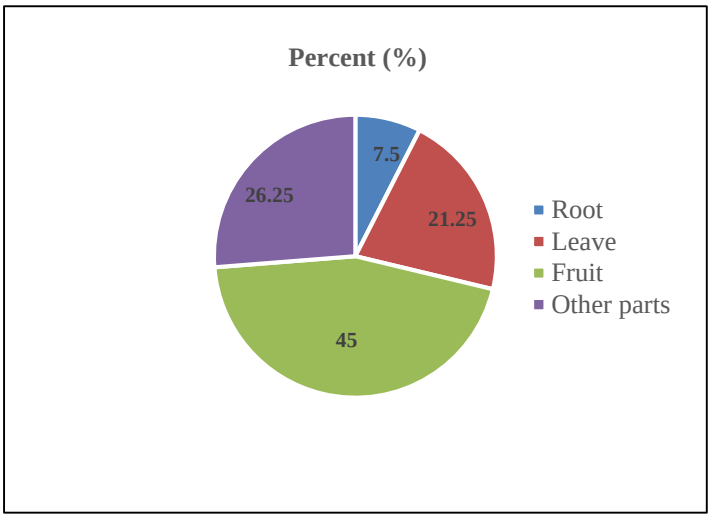

Figure 1. The Parts of the medicinal and aromatical plants used help to remove side effects of RT

The common preparation of the traditional folk medicine is eaten fresh (29), followed by fruit juice (25), food purpose (22) and cooked (20). Other types of preparations and the number of taxa are given in Figure 2.

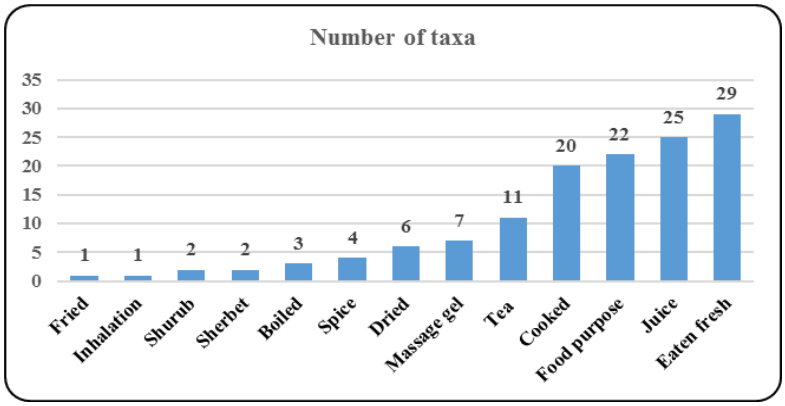

Figure 2. Application and Consumption values of medicinal and aromatical plants in RT.

These plants are most commonly used for the treatment of oxidative stress (20.49 per cent), followed by skin reactions (17.21 per cent) and cardiovascular diseases (12.30 per cent) in radiotherapy patients (Figure 3).

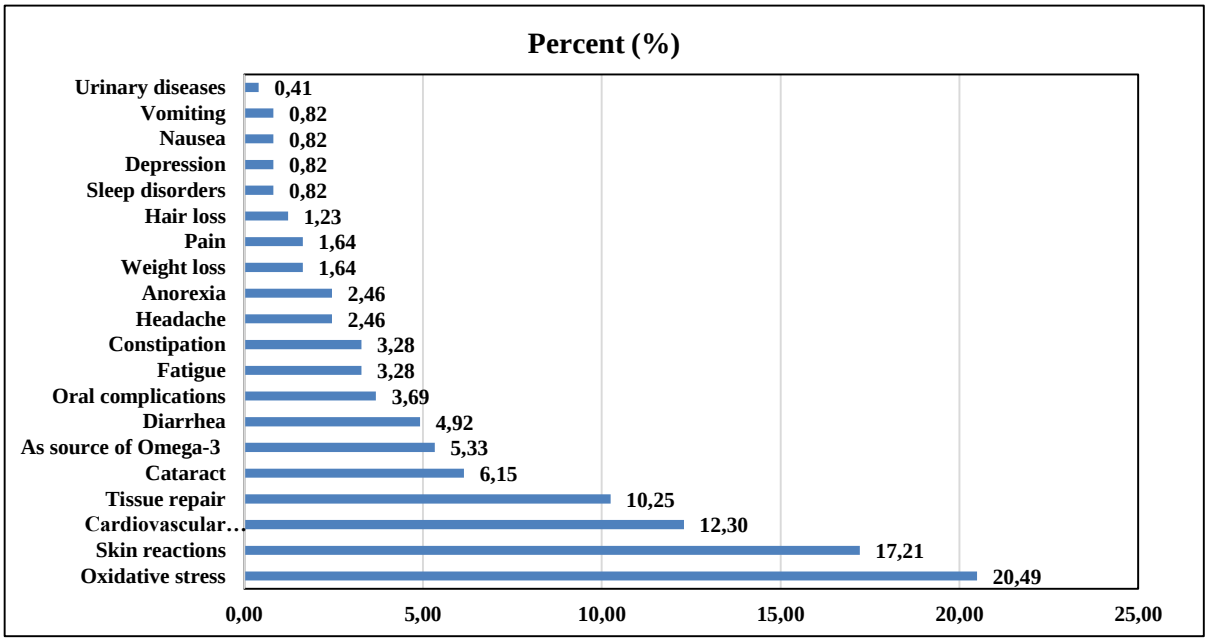

Figure 3. Therapeutic uses of the medicinal and aromatic plant taxa in RT.

Some of the these medicinal and aromatical plant in RT are sold as spice, fruits and vegetables by herbalist, local markets and bazaars in many region and culture of the world. Most important ones are; *Allium cepa*, *Allium sativum* (Alliaceae), *Spinacia oleracea* (Amaranthaceae), *Daucus carota* (Apiaceae), *Brassica oleracea* (Brassicaceae), *Juglans regia* (Juglandaceae), *Morus* sp. (Moraceae), *Musa* sp. (Musaceae), *Citrus sinensis* and *Citrus limon* (Rutaceae), *Mentha* sp. (Lamiaceae), *Alpinia officinarum* and *Zingiber officinale* (Zingiberaceae) (Altay et al. 2015; Öztürk et al. 2017).

4. Conclusions and discussion

The many studies have reported that natural and healthy nutrition is very important in cancer treatments. Most radiotherapy patients (80.9%) experienced to side effects like fatigue, nausea, vomiting and loss of appetite were the most frequent during/after the treatments (Güleser et al., 2012). Many cancer survivors are highly motivated to seek information about food choices, physical activity, dietary supplement use, and complementary nutritional therapies to improve their response to treatment, speed recovery, reduce risk of recurrence, and improve their quality of life. Numerous studies have suggested that vitamins A, B12, C and secondary

metabolites such as Omega-3 fatty acids, resveratrol, genistein, riboflavonoid and saponins may have specific benefits for cancer survivors, such as ameliorating cachexia, improving quality of life, and perhaps enhancing the effects of some forms of treatment (Patel et al., 2014; Rigo et al., 2015). Similarly in this review, most commonly used plants as follows: Allium sativum L. (garlic), Juglans regia L. (walnut) and Solanum lycopersicum L. (tomatoes) for treatment to side effects of radiotherapy. However, cancer patients limit or don't have: drinks with alcohol, with caffeine (e.g. coffee and black tea), with carbonated (e.g. sodas and colas), spicy foods and tobacco products. Finally, good quality diet activity, natural vegetables, fruits and the other medicinal plants may help patients to increase protein and calorie intake, improve weight status, and protect quality of life in radiotherapy patients. In summary, a variety of some medicinal and aromatic plants have been shown to be effective to remove side effect of radiotherapy in cancer.

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