Chapter 6

The Potential of Medicinal and Aromatic Plants to Prevent Prostate Cancer

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Abstract

Medicinal and aromatic plants have been used in the prevention and treatment of diseases since ancient times. Today, they are used in the production of diverse commodities such as food, perfumery, cosmetics, medicine, textile, spices, paints, and pesticides. Prostate cancer is the second most common type of cancer in men. Early treatment of prostate cancer becomes important, and it is important to develop different treatment methods.

This chapter envisaged to represent the work performed on caper (*Capparis spinosa* L.), carob (*Ceratonia siliqua* L.), hawthorn (*Crataegus monogyna* L.), quinoa (*Chenopodium quinoa* L.), rosehip (*Rosa canina* L.), golden grass (*Helichrysum arenarium* L.), mallow (*Malva parviflora* L.), stevia (*Stevia rebaudiana* L.), gojiberry (*Lycium barbarum* L.), and coriander (*Coriandrum sativum* L.). Extracts obtained from these plants will be characterized by mass spectrometry and their activities will then be screened on some of the important proteins cancer (Protein Data bank ID: 3RUK, 6XXP, 3A99, 3G1R, 2AMA and 3EQM)

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by molecular docking approach. Afterwards, ADME/T properties of the promising extract components will be characterized.

Keywords: aromatic plant extracts, medicinal plant extracts, molecular modelling, prostate cancer

Introduction

Plants are considered one of the most important sources of industrial drugs (Ashraf et al., 2016; Muhammad et al., 2016). Global interest in complementary and alternative medicine has increased recently (Hussain et al., 2012). Despite the lack of scientific knowledge about the effectiveness of phytomedics, their use as complementary and alternative medicine has gained more acceptance (Hossen et al., 2015; Nasir et al., 2015).

Eighty percent of the population in developing countries benefit from medicinal plants in the treatment of many diseases (WHO, 2009). In recent years, there has been increasing interest in research on the potential bioactivity and nutritional importance of different phytochemical components (Rates, 2001). The structural diversity of natural compounds, especially that of flavonoids, in plant flowers encourages the hopes in the finding of new (López-Lázaro, 2002). And it is essential that newly discovered chemicals should be structurally characterized (Russell and Duthie, 2011; Nazar et al., 2020).

In vitro studies have focused on the direct and indirect effects of plant compounds on tumor cells. Various antitumor effects have been found, including inhibition of cell growth and kinase activity, induction of apoptosis, inhibition of constitutive metalloproteinase secretion, and metastasis (Rodrigues et al., 2012; Spencer et al., 2004).

Cancer is the second cause of death worldwide (Demir et al., 2016; Naghibi et al., 2014) and in cancerous cases prostate cancer is the second commonest cause of death in men (Kim et al., 2013), first being the lung cancer (Amararathna et al., 2016). Therefore, lung and prostate cancers constitute a global threat to the human species. Chemo-and radiotherapies are often opted for the treatment of these cancers (Turan et al., 2017) that both have severe side effects and therapeutic limitations. New pharmacological treatments are needed to alleviate these problems (Demir et al., 2016; Kilinc et al., 2020).

In men, the prostate is a gland located in the lower abdomen, producing fluids to protect sperm. Because the gland is located next to the rectum and bladder, it is protected by a thin layer of collagen and smooth muscle. The prostate gland is enclosed by the urethra and facilitates secretions prior to ejaculation (Nelson et al., 2003). In advanced ages the prostate gland often enlarges and becomes inflamed, leading to a significant increase in the level of prostate-specific antigen (PSA) in the blood, that is a useful marker for the diagnosis prostate cancer. PSA levels are elevated near the urethra and cause both the peripheral proliferative atrophy (PIA) and prostate intraepithelial neoplasia (PIN) in Figure 1A. In some cases, however, prostate PSA density may not be sufficient in detecting prostate cancer in the cases in which the tumor may develop in the complete absence of antigen. Early diagnosis and treatment of prostate cancer therefore gains great importance (Xue et al., 2021).

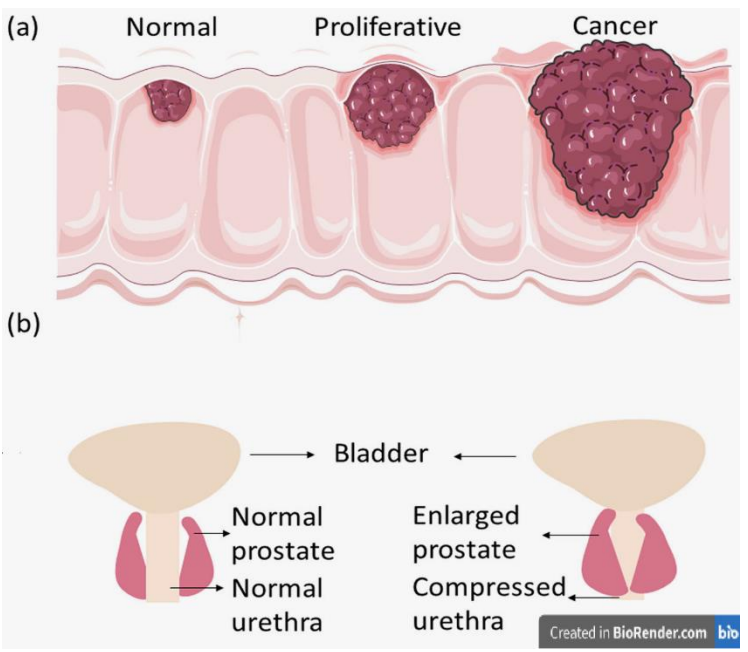

Figure 1. Prostate cancer progression. (A) Activation of prostate tumor proliferation and ultimately prostate cancer. (B) An illustration of a normal prostate gland and an enlarged prostate gland due to the proliferation of prostate tumors compressing the urethra (Xue et al., 2021).

Prostate cancer cells are often originated from the epithelial compartment of the prostate gland. Prostate tumors arising from basal epithelial cells are unusual. In addition, neoplastic prostate epithelial cells can differentiate into tumor cells. Neoplastic epithelial cells act as an intermediary between basal cells and columnar secretory epithelial cells to accelerate tumor growth (Rao et al., 2019).

Early prostatitis does not cause significant symptoms, so it is difficult to recognize. Severe inflammation affects the urethra, as it is surrounded by the prostate gland. About 50% of men with urethral pain are caused by an enlarged and inflamed prostate gland that causes difficulty urinating and severe pain in the lower abdomen in Figure 1B (Xue et al., 2021).

There are many methods and applications for the treatment of cancer patients. It is known by everyone that these methods and applications have made great progress in the last century. Advances in oncology continue to contribute to the lives of more and more patients, with treatments used alone or in combination. Increasing diversity in treatment can be confusing, especially for patients or their relatives. One of the types of treatment applied is Immunotherapy, which is the type of treatment that uses drugs that stimulate the immune system to recognize and destroy cancer cells more effectively.

Figure 2. Some prostate cancer drugs.

Another method that comes to mind first when talking about cancer treatment today is chemotherapy, which is a drug or drugs used to directly cure cancer. Discovered in the 1950s, the goal of these drugs is to directly destroy fast-growing and proliferating cancer cells or to control the growth of cells.

For this reason, chemotherapies are called cytotoxic (cell-killing) agents. Chemotherapy can be used to treat cancer completely, or to reduce the risk of cancer recurrence or to stop or slow its growth.

In both methods, important drugs are used. The active ingredients of these drugs have been obtained from chemicals found in plants that exist in nature. Subsequently reproduced by synthesizing them. Therefore, medicinal and aromatic plants found in nature are very, very important in this respect. By examining these plants in more detail, it has become more important to find more effective and active drugs for prostate cancer. Some of the chemicals found in the following ten medicinal and aromatic plants were examined for their activities against prostate cancer proteins.

Medicinal and Aromatic Plants

Capparis spinosa L. Plant

The medicinal plant, *Cappari spinosa* contains many biologically active chemical groups including alkaloids, glycosides, tannins, phenolics, flavonoids, triterpenoids, steroids, carbohydrates, saponins and minerals beside various trace elements. It has many pharmacological effects, including antibacterial, cytotoxic, antidiabetic, anti-inflammatory, antioxidant activities (Rahnavard and Razavi, 2016).

Capparis spinose L. belongs to the family *Capparaceae*, native to the Mediterranean region and is generally well adapted to arid basins (Chalak and Elbitar, 2006; Sozzi and Vicente, 2006). It is one of the aromatic perennials, growing on roadsides, slopes, and Rocky Mountains. The average annual temperature in the cultivated areas is above 14°C and the precipitation varies from 200 mm/year in Spain to 460 in Pantelleria and 680 in Salina. From May to August, only 35mm rain falls on Pantelleria and 84mm on Salina. A wet spring and a warm and dry summertime season are taken into consideration advantageous. This drought-tolerant perennial has an advantageous effect on the surroundings and is used for landscaping and lowering erosion on roadsides, steep rocky slopes, dunes or fragile semi-arid ecosystems (Rahnavard and Razavi, 2016).

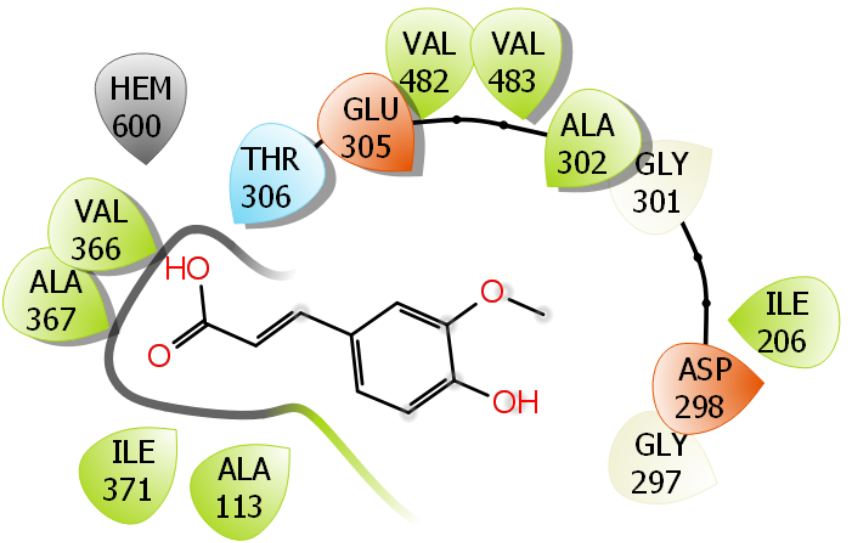

Figure 3. Demonstration of the interaction of ferulic acid molecule with prostate cancer.

The whole plant has been used for rheumatism. The bark is also used for gout and rheumatism, as an expectorant and for treating the lungs. The root has been used as a diuretic, astringent, and tonic. Root bark has a bitter taste, used as an aperitif, astringent, tonic, treatment of diarrhoea and haemorrhoids, and of spleen and stomach diseases. The roots and root bark have been used as antidiarrheal and antipyretic. Its fresh fruit has been used for sciatica and sagging. Dried fruit and its powder combined with honey have been used to combat colds, rheumatism, gout, sciatica, and back pain. Crushed leaves are applied as painkillers in head- and toothaches (Zhou et al., 2010; Al-Snafi, 2015). Capers contain more quercetin (quercetin) per weight than any other herb (Darwish and Aburjai, 2010; Yang et al., 2010). The root bark and leaves of this plant may have anticancer activity (Razavi et al., 2016). Glucosinolate is also known to have goitrogenic (antithyroid) activity. Selenium, found in higher concentrations in capers than in other herbal products, has also been linked to preventing certain types of cancer. A recently discovered phytochemical stahydrin may possess potent anti-inflammatory properties in the prevention of prostate cancer. It seems to inhibit DNA replication and thus interfere with the proliferation of cancer cells. This scientific discovery is a

real step forward in the development of effective drugs against prostate cancer (Rahnavard and Razavi, 2016).

The plant *Capparis spinosa* L. has been used for many studies. These studies show that *Capparis spinosa* L. plant can be used as an important medicine for various cancer diseases. GC-MS analysis is commonly performed to detect the chemicals in this plant. As a result of this analysis, it was seen that Ferulic acid is more in mass. Accordingly, the interaction of this Ferulic acid molecule with prostate cancer is given in Figure 3.

Ceratonia siliqua L. Plant

The carob tree (*Ceratonia siliqua* L.) is one of the most beneficial plants in the Mediterranean basin. Its seeds are mainly used in the locust bean gum production (LBG, E410). Carob leaves and pulps are rich in phenolic compounds and have antioxidant and antiproliferative activities (Custodio et al., 2009). Its leaf extracts are known to have anxiolytic and sedative effects (Avallone et al., 2002). A polyphenol-rich carob leaf extract has reduced the viability of a human adenocarcinoma (HeLa) prostate (DU-145), breast (MDAMB-231) and colon (HCT-166) cell lines (Custódio et al., 2011).

Several studies have highlighted the relationship between apoptosis and cancer, and there is growing evidence that the processes of tumorigenesis, progression, and metastasis are involved in the decline of tumor cells. normal apoptosis pathway (Bold et al., 1997). Apoptosis, a morphologically distinct form of programmed cell death, is a highly conserved evolutionary phenomenon that plays an important role in the regulation of cellular activities in eukaryotes. Apoptosis is also a major cellular response to chemotherapeutic agents (Reed, 2001). Since compounds exhibiting apoptosis-inducing activity have been recognized as potential anti-tumor agents (Frankfurt and Krishan, 2003), much effort has been devoted to the discovery of new drugs by isolating apoptotic agents from natural products (Custódio et al., 2011).

Ceratonia siliqua L. plant is an important plant used in many anti-cancer studies.

This plant contains many chemicals in it. As a result of the GC-MC analysis performed to determine the chemicals in the *Ceratonia siliqua* L. plant, it is seen that the (+)-Catechin molecule has a higher mass percentage than the others. The interaction of the (+)-Catechin molecule with the prostate cancer protein is given in Figure 4.

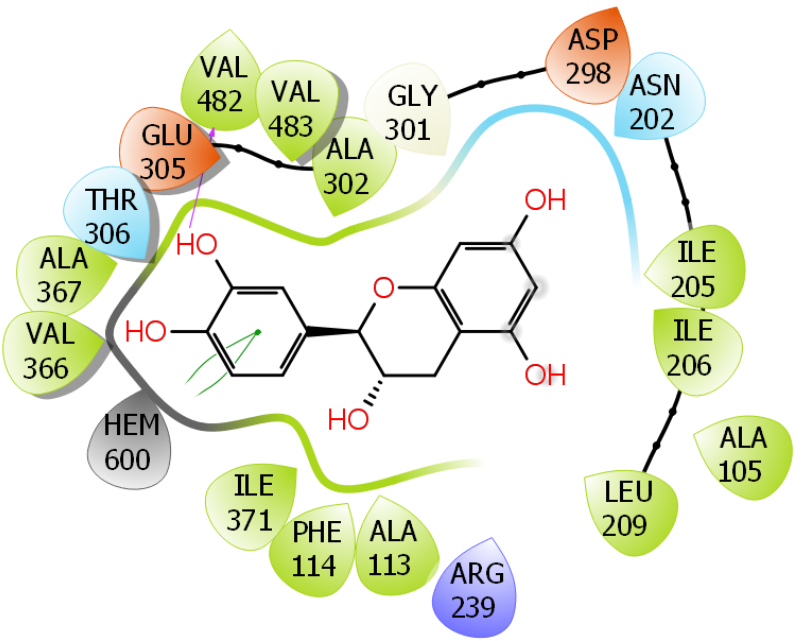

Figure 4. Demonstration of the interaction of the (+)-Catechin molecule with prostate cancer.

Crataegus monogyna L. Plant

This species, a traditional medicine, called “hawthorn” in Turkey, is widely grown in Europe, America, and Asia (Bardakci et al., 2019). It is edible and rich in bioactive or phytonutrients. Hawthorn species are extensively utilized as conventional medicinal drug material to treat congestive coronary heart failure, angina, hypertension, and arrhythmia. In China *Crataegus* species have been used to relieve blood stasis, improve circulation, treat diarrhoea, indigestion, hyperlipidaemia, hypertension as well as abdominal pain. In Europe it has been exploited in the treatment of heart problems thanks to its antispasmodic, antispasmodic, antispasmodic and hypotensive properties (Edwards et al., 2012). *Crataegus* species have also been reported to exhibit immunostimulatory, non-infectious, antiviral, anti-lipoperoxide, antibacterial, anti-inflammatory, lipid-lowering, hepatoprotective, gastroprotective, and associated hypoglycemic activities due to their phenolic constituents,

proanthocyanins, triterpenoids, and flavonoids (Venskutonis, 2018; Deveci et al., 2020).

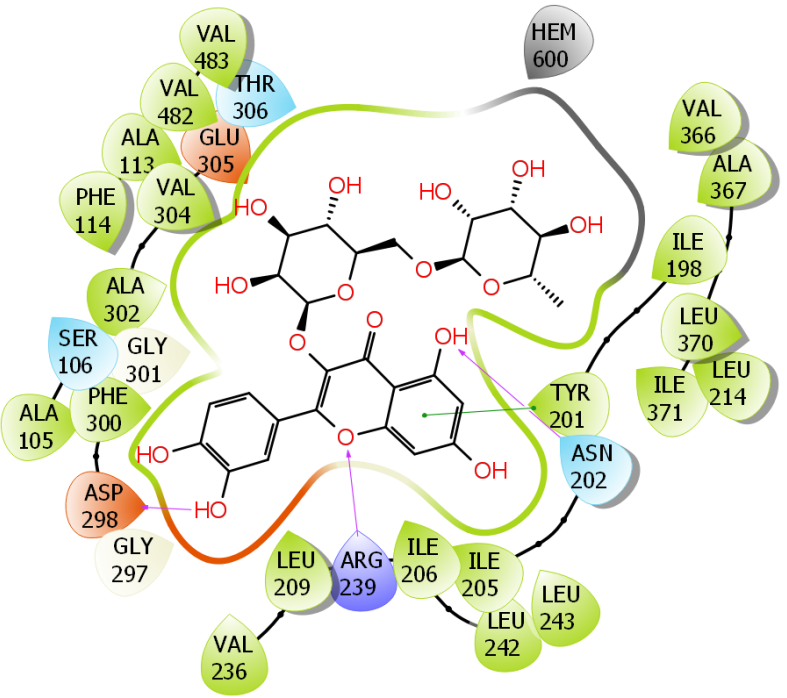

Figure 5. Demonstration of the interaction of the rutin molecule with prostate cancer.

Crataegus monogyna Jacq. Hawthorn, one of the most recommended species in folk medicine, is often eaten by shepherds, hunters, and children because its seeds are "healthy" and nutritious (Carvalho, 2010). The nutritional composition of hawthorn flowers and fruits have also been reported (Barros et al., 2011). The flowers revealed the highest tocopherol and ascorbic acid content as well as the best n-6/n-3 fatty acid ratio; ripe fruit has the highest content of carbohydrates, sugars, and saturated fatty acids. Unripe fruit offers the highest levels of polyunsaturated fatty acids as well as the most promising antioxidant properties (Barros et al., 2011; Rodrigues et al., 2012).

Crataegus monogyna L. plant is an important plant used in many anti-cancer studies. This plant contains many chemicals in it. As a result of the GC-MC analysis performed to determine the chemicals in the Crataegus monogyna L. plant, it is seen that the routine molecule has a higher mass

percentage than the others. The interaction of rutin molecule with prostate cancer protein is given in Figure 5.

Chenopodium quinoa L. Plant

It is an historical plant grown regionally in Bolivia, Peru, and Chile (Repo-Carrasco et al., 2003). Its products contain nutritionally important molecules: vanillic acid, ferulic acid and their derivatives, quercetin, kaempferol, and their glycosides, vitamins (ascorbic acid, thiamine, riboflavin and -tocopherol) (Vega-Galvez et al., 2010; Tang et al., 2015). These compounds enable this plant to be one of the most valuable in the 21st century (Graf et al., 2014). This plant has been widely cultivated in East Asia, Europe, Africa, and the Americas. The seeds of this salt-tolerant plant can be used to make cereal puffs or ground into flour for baking. Edible quinoa seed oil has valuable properties such as antioxidant and antimicrobial effects (Sakar et al., 2021; Shen et al., 2022).

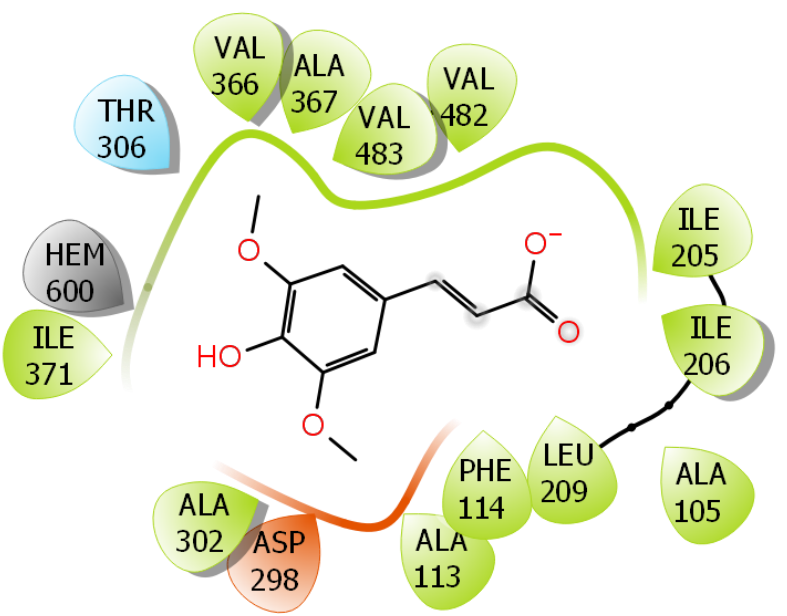

Figure 6. Demonstration of the interaction of the sinapic acid molecule with prostate cancer.

Chenopodium quinoa L. plant is an important plant used in many anti-cancer studies. This plant contains many chemicals in it. As a result of the GC-MC analysis performed to determine the chemicals in the *Chenopodium quinoa* L. plant, it is seen that the Sinapic acid molecule has a higher mass percentage than the others. The interaction of the sinapic acid molecule with the prostate cancer protein is given in Figure 6.

Rosa canina L. Plant

This traditional medicine plant, Rosehip, is a shrub that grows wild in Europe, northwest Africa, and western Asia. It has prophylactic and therapeutic effects against colds, infectious diseases, digestive disorders, urinary tract diseases and inflammatory diseases (Chrubasik, et al., 2008; Wenzig et al., 2008). Rosehip powder has been shown in clinical studies to reduce symptoms of osteoarthritis (Christensen et al., 2008; Ilyasoğlu, 2014).

The health benefits of rosehip are attributed to the presence of bioactive compounds including ascorbic acid, carotenoids, and phenolic compounds. Rosehip has long been used as an herbal tea and vitamin supplement in Europe, as it has the highest ascorbic acid content among fruits and vegetables (Demir and Ozcan, 2001). Fresh rosehips are eaten as a snack and dried rosehips are made into products such as tea, jam, nectar, marmalade and fruit pulp (Ercisli, 2007). The seeds are used in animal feed. The lipid fraction of rosehip seeds consists of many polyunsaturated fatty acids (Szentmihalyi et al., 2007). Rosehip oil is utilized in cosmetology to deal with pores and skin disorders (Ilyasoğlu, 2014).

Rosa species are historically used as the remedy of colds, asthma, hemorrhoids, infections, persistent pain, arthritis, and inflammatory diseases (Turan et al., 2018). Their berries are affluent in nutrition C, minerals, carotenoids, tocopherols, flavonoids, fruit acids, tannins, pectin, sugars, natural acids, amino acids and vital oils (Roman et al., 2013). Due to the presence of these constituents, it has anti-cancer, antioxidant, anti-inflammatory, anti-diabetic, hyperlipidaemic, antibacterial, hepatoprotective, neuroprotective, anti-aging properties, antibacterial and antibiotic activities (Marmol et al., 2017). *Rosa damascena* extracts had a dose-dependent cytotoxic activity on several cancer cell lines: HeLa (Zamiri-Akhlaghi et al., 2011), human colon cancer (HT-29, Caco-2), breast cancer (MCF-7) (Jimenez et al., 2016). In one study, it has also been demonstrated that *Rosa canina*

extract could inhibit the proliferation of both lung- and prostate cancer cells (Kilinc et al., 2020).

Rosa canina L. plant is an important plant used in many anti-cancer studies. This plant contains many chemicals. As a result of the GC-MC analysis performed to determine the chemicals in the *Rosa canina* L. plant, it is seen that the ellagic acid molecule has a higher mass percentage than the others. The interaction of ellagic acid molecule with prostate cancer protein is given in Figure 7.

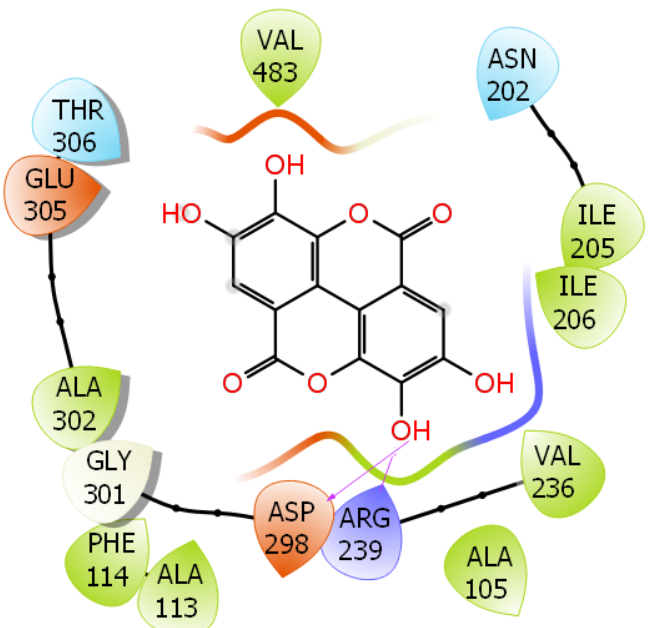

Figure 7. Demonstration of the interaction of the ellagic acid molecule with prostate cancer.

Helichrysum arenarium L. Plant

Helichrysum arenarium L., a fragrant plant known as the flower of immortality or chrysanthemum, grows wild in Anatolia and is widely used as an herbal tea. It is used in the treatment of kidney stones, urogenital disorders, stomach pain, jaundice, diarrhoea, and asthma (Tabata et al., 2013). This plant harbours a variety of biological properties, including antioxidant, heap-

toprotective, biliary, choleretic effects (Czinner et al., 2000) beside antibacterial, antiviral, and antifungal activities (Aslan et al., 2006). It is a good source of flavonoids, phenols, polyphenols, flavones, essential oils, polysaccharides, glycosides, and coumarins (Eroğlu et al., 2010).

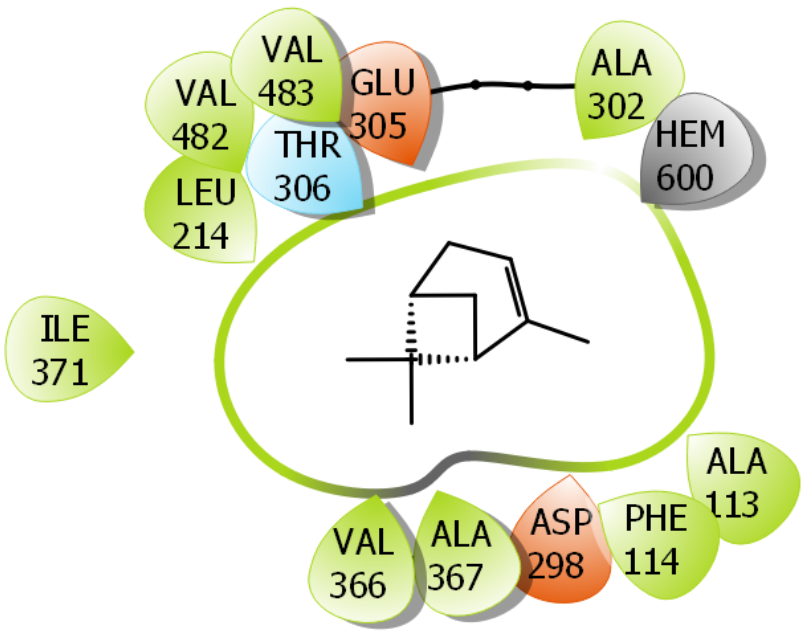

Figure 8. Demonstration of the interaction of the alpha-Pinene molecule with prostate cancer.

Helichrysum arenarium L. plant is an important plant used in many anti-cancer studies. This plant contains many chemicals. As a result of the GC-MC analysis performed to determine the chemicals in *Helichrysum arenarium* L. plant, it is seen that the alpha-Pinene molecule has a higher mass percentage than the others. The interaction of the alpha-Pinene molecule with the prostate cancer protein is given in Figure 8.

Malva parviflora L. Plant

Malva parviflora L. belongs to the family Malvaceae. Hot poultices made from the leaves are also used to treat sores and swelling and are added to

lotions to treat bruised and broken limbs (Shale et al., 1999). The leaves of *Malva parviflora* had been utilized by the Xhosa human beings of South Africa to deal with swollen and inflamed purulent wounds (Watt and Breyer-Brandwijk, 1962).

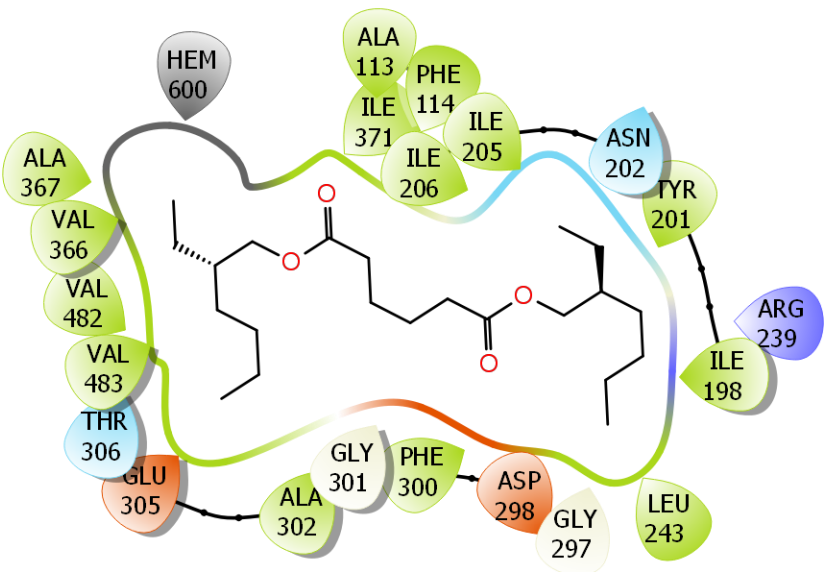

Figure 9. Demonstration of the interaction of the hexanedioic acid, bis(2-ethylhexyl)ester molecule with prostate cancer.

However, it can be toxic if ingested as *Malva parviflora* has been reported to be fatal to feeders such as sheep, horses and cattle. Sheep are affected most often and develop clinical signs such as tremors, back tremors, and dyspnea (Watt and Breyer-Brandwijk, 1962). In a recent study, it was found that the methanol fraction of polyphenols obtained from the leaves and stems of this plant contains many phenols, flavonoids, saponins, alkaloids, resins, and tannins. In the same study, this methanol fraction showed high antioxidant capacity (Farhan et al., 2012).

Malva parviflora L. plant is an important plant used in many anti-cancer studies. This plant contains many chemicals. As a result of the GC-MC analysis performed to determine the chemicals in *Malva parviflora* L. plant, it is seen that the Hexanedioic acid, bis(2-ethylhexyl) ester molecule has a higher

mass percentage than the others. The interaction of hexanedioic acid, bis(2-ethylhexyl)ester molecule with prostate cancer protein is given in Figure 9.

Stevia rebaudiana L. Plant

The edible plant *Stevia rebaudiana* Bertoni, also known as Honey Leaf, Sweet Leaf or Sweet Plant, produces the sweet steviol glycoside (Ceunen et al., 2013). The plant is a perennial shrub growing mainly in South America, especially in Brazil and Paraguay. In preparation the whole plant is used. Its extracts constitute excellent zero-calorie sugar substitutes for synthetic sweeteners and natural sugar (Carrera-Lanestosa et al., 2017).

In particular, the anti-diabetic, antihypertensive, anti-tumor, anti-inflammatory, anti-swelling, and bactericidal effects of the plant have been investigated (Ranjbar et al., 2020). *Stevia*'s properties have been studied for over 100 years in Figure 10 (Peteliuk et al., 2021).

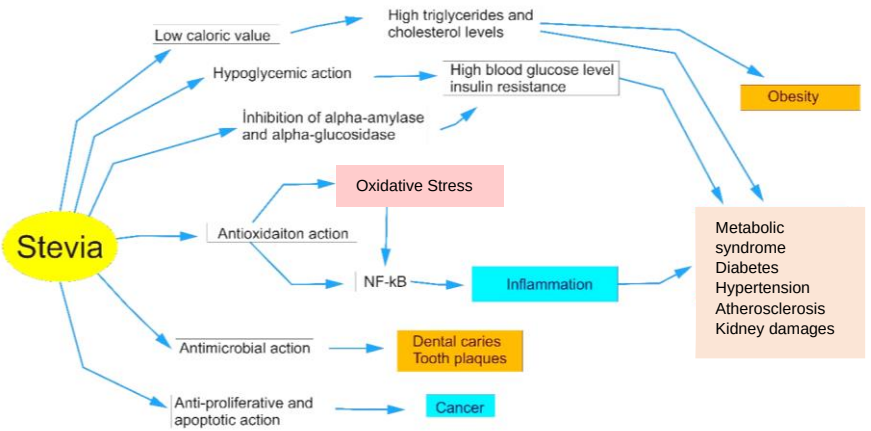

Figure 10. Health benefits of Stevia leaf extracts (Peteliuk et al., 2021).

Steviol appeared to have inhibited the proliferation of six different cancers cell lines, involving the gastrointestinal tract (Chen et al., 2018). It should also be noted that stevioside is less toxic to normal cells at highly elevated doses. This compound can also seem to inhibit DNA synthesis and induce the mitochondrial apoptotic pathway probably by increasing the expressions of p21 and p53. Overall, stevioside promises to be a potent antitumorous agent (Paul et al., 2012; Konoshima and Takasaki, 2002; Yasukawa et al., 2002). In

addition, steviol, isosteviol and their metabolites can block the induction of an early Epstein Barr virus antigen and inhibit tumor progression in Figure 11 (Peteliuk et al., 2021).

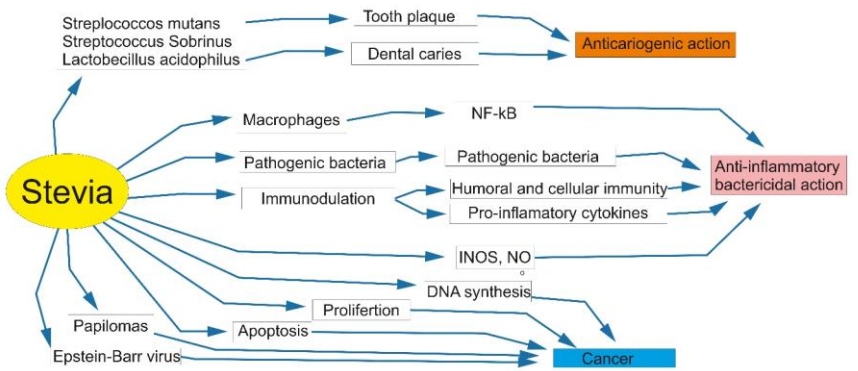

Figure 11. Overall beneficial properties of *Stevia* extracts (Peteliuk et al., 2021).

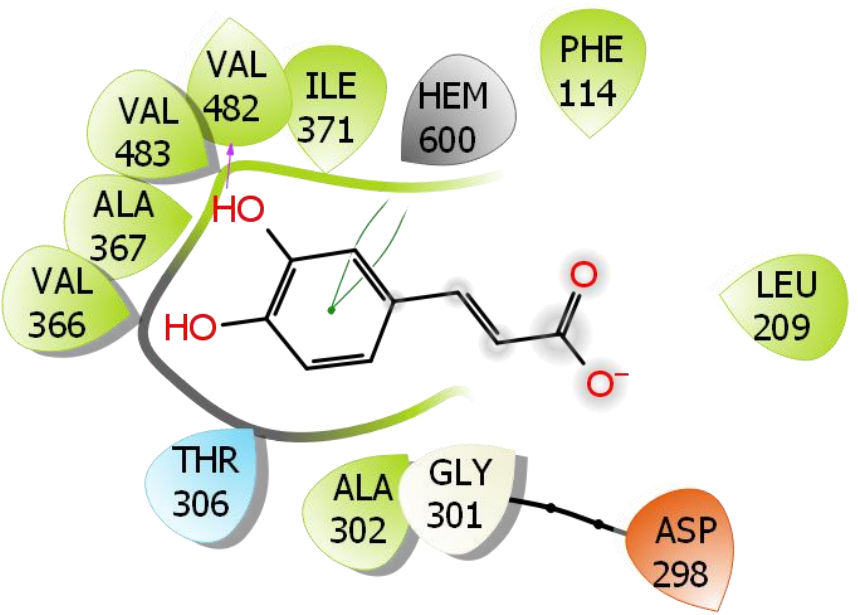

Figure 12. Demonstration of the interaction of the caffeic acid molecule with prostate cancer.

Stevia rebaudiana L. plant is an important plant used in many anti-cancer studies. This plant contains many chemicals. As a result of the GC-MC analysis performed to determine the chemicals in the *Stevia rebaudiana* L. plant, it is seen that the caffeic acid molecule has a higher mass percentage than the others. The interaction of the caffeic acid molecule with the prostate cancer protein is given in Figure 12.

Lycium barbarum L. Plant

The ripe red fruit of *Lycium barbarum* L. (family Solanaceae), commonly known as goji berry or goji, is a traditional Chinese herb. Now, this is a popular functional food worldwide, lowering blood sugar and serum lipids, regulating the immune system, anti-cancer, anti-aging, anti-fatigue, and increasing male fertility (Gao et al., 2000) as well as delaying aging, improving eyesight, and protecting liver (Zhang et al., 2005). The red fruit of *L. barbarum*, therefore, has the most important functional components (Gan et al., 2004). Five polysaccharides (LbGp1 – LbGp5) (glycoconjugates) have been isolated and structurally defined (Luo et al., 2006).

Possible merits of LBPs on the treatment of prostate cancer have not been known (Xiong et al., 2008). Prostate cancer cells grow and proliferate rapidly, and have a high metastatic potential (Stone et al., 2002). Studies (Lu et al., 2002; Sheng et al., 2002) have shown that LBP can induce apoptosis in various cancer cells and slow tumor growth in animals. Therefore, the aims of the present study were (Gao et al., 2000) to investigate the inhibitory effect of LBP on human prostate cancer cell lines (PC-3 and DU-145) in vitro and (Li, 2001) to evaluate the in vivo efficacy of LBP in the intervention of a murine PC-3 xenograft tumor model. PC-3 xenograft tumor model (Luo et al., 2009).

Lycium barbarum L. plant is an important plant used in many anti-cancer studies. This plant contains many chemicals. As a result of the GC-MC analysis performed to determine the chemicals in the *Lycium barbarum* L. plant, it is seen that the ethyl lactate molecule has a higher mass percentage than the others. The interaction of the ethyl lactate molecule with the prostate cancer protein is given in Figure 13.

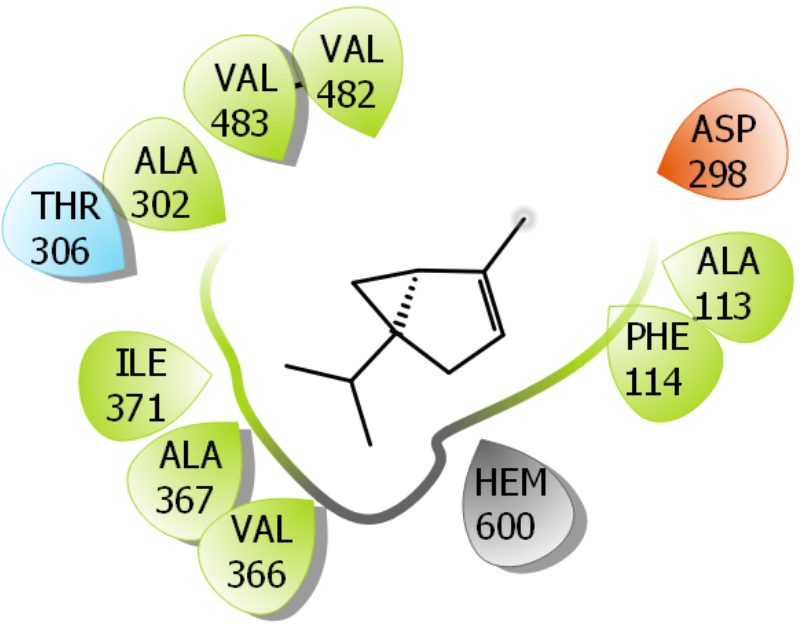

Figure 13. Demonstration of the interaction of the ethyl lactate molecule with prostate cancer.

Coriandrum sativum L. Plant

Coriander seeds, roots and leaves are used in many fields ranging from food to medicine and cosmetics (Zhang et al., 2015). Each organ of this plant seems to have both antioxidant ant anti-cancer effects in vitro (Elmas et al., 2019).

Coriandrum sativum leaf extracts, silver seeds and *Coriandrum sativum* root extracts have shown "anti-cancer" effects on MCF-7 breast cancer cells (Tang et al., 2013; Sathishkumar et al., 2016). *Coriandrum sativum* has also been reported to protect against chemotactic carcinogens in colon cancer when consumed daily (Chithra and Leelamma, 2000). The methanol extracts obtained from *Coriandrum sativum* have also been reported to be highly toxic in L5178Y-R lymphoma cells in vitro (Gomez-Flores et al., 2010). In vitro experiments with normal human fibroblasts and nude mice suggest a protective role against *Coriandrum sativum* UVB-induced reactive oxygen species.

Prostate cancer has been reported as the most common non-skin cancer in American and Western men and is the second leading cause of cancer-related death. Unlike the localized, slow-growing version of prostate cancer, it can also be very potent. The chronic and life-threatening nature of prostate cancer makes low-toxic and highly effective treatments crucial (Cotter et al., 2016). Tumors have also struggled with traditional treatments, finding ways to become more hormone-independent and aggressive. Many new chemotherapy drugs such as ipuleucel-T, enzalutamide, and cabozantinib all have negative side effects (Wang and Martins-Green, 2014). So, natural remedies that have a strong effect against prostate cancer but have no side effects or are negligible are very important. Perhaps this is why 25% of prostate cancer patients use at least one complementary and alternative medicine (CAM) treatment. Many CAM agents are still awaiting confirmation of prostate cancer (Philippou et al., 2013).

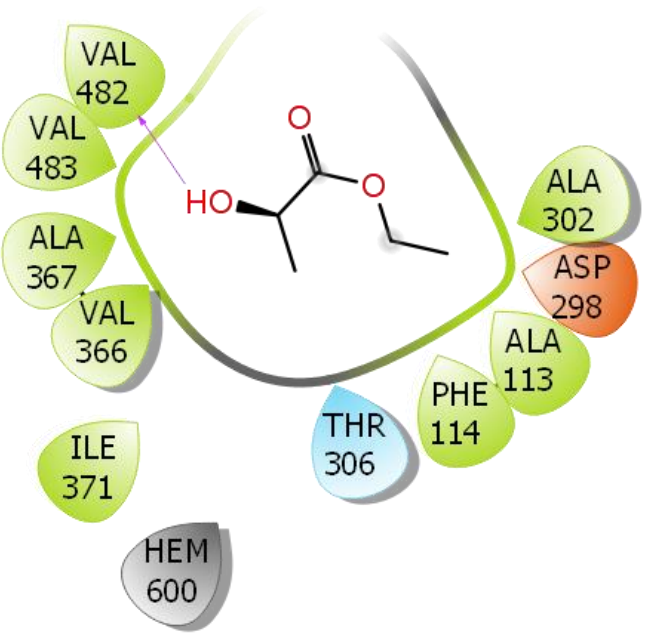

Figure 14. Demonstration of the interaction of the alpha-thujene molecule with prostate cancer.

Coriandrum sativum L. plant is an important plant used in many anti-cancer studies. This plant contains many chemicals. As a result of the GC-MC analysis performed to determine the chemicals in the *Coriandrum sativum* L. plant, it is seen that the alpha-thujene molecule has a higher mass percentage than the others. The interaction of the alpha-thujene molecule with the prostate cancer protein is given in Figure 14.

Conclusion

Prostate cancer has led to many studies on it because it is the second most common type of cancer in men's metabolism compared to other cancer types. However, although there are many treatment methods, drug therapy is used more than others. In this way, it is hoped that it will reduce cancerous cells and slow down their development. Therefore, the discovery of new and effective drugs gains great importance. All medicines used today are derived from chemicals found in plants found in nature. In this direction, the chemicals in ten medicinal and aromatic plants were examined and the activities of chemicals with a higher percentage by mass against prostate cancer were investigated.

References

Al-Snafi, A. E. (2015). *Encyclopedia of the Constituents and Pharmacological Effects of Iraqi Medicinal Plants.* Rigi Publication, India.

Amararathna, M., Johnston, M. R. and Vasantha Rupasinghe, H. P. (2016). Plant polyphenols as chemopreventive agents for lung cancer. *IJMS*, 17, 1352.

Ashraf, M. U., Muhammad, G., Hussain, M. A. and Bukhari, S. N. A. (2016). *Cydonia oblonga* M., A medicinal plant rich in phytonutrients for pharmaceuticals. *Front. Pharmacol.*, 7, 163.

Aslan, M., Özçelik, B., Orhan I., Karaoglu, T. and Sezik, E. (2006). Screening of antibacterial, antifungal and antiviral properties of the selected Turkish Helichrysum species. *Planta Med*., 72, 997-997.

Avallone, R., Cosenza, F., Farina, F., Baraldi, C. and Baraldi, M. (2002). Extraction and purification from *Ceratonia siliqua* of compounds acting on central and peripheral benzodiazepine receptors. *Fitoterapia*, 73, 390-396.

Bardakci, H., Celep, E., Gözet, T. and Kan, Y. (2019). Kırmızıbekmez H. Phytochemical characterization and antioxidant activities of the fruit extracts of several Crataegus taxa. *S. Afr. J. Bot.* 124, 5-13.

Barros, L., Carvalho, A. M. and Ferreira, I. C. F. R. (2011). Comparing the composition and bioactivity of *Crataegus monogyna* flowers and fruits used in folk medicine. *Phytochemical Analysis*, 22, 181–188.

Bold, R. J., Termuhlen, P. M. and McConkey, D. (1997). Apoptosis, cancer and cancer therapy. *Surg. Oncol*., 6, 133-142.

Carrera-Lanestosa, A., Moguel-Ordóñez, Y. and Segura-Campos, M. (2017). *Stevia rebaudiana* Bertoni: A natural alternative for treating diseases associated with metabolic syndrome. *J. Med. Food*, 20, 933–43.

Carvalho, A. M. (2010). Plantas y sabiduría popular del Parque Natural de Montesinho. Un estudio etnobotánico en Portugal [*Plants and popular wisdom of the Montesinho Natural Park. An ethnobotanical study in Portugal*]. *Biblioteca de Ciencias, 35, Madrid: Consejo Superior de Investigaciones Científicas* (CSIC).

Ceunen, S., Wim, D. B., Compernolle, F., Mai, A. H. and Geuns, J. M. C. (2013). Diterpene glycosides from *Stevia phlebophylla* A. *Gray. Carbohydr Res*., 379, 1–6.

Chalak, L. and Elbitar, A. (2006). Micropropagation of *C. spinosa* L. subsp rupestris Sibth and Sm by nodal cuttings. *Indian J. Biotechnol*., 5, 555-8.

Chen, J., Xia, Y., Sui, X., Peng, Q., Zhang T, Li J. and Zhang, J. (2018). Steviol, a natural product inhibits proliferation of the gastrointestinal cancer cells intensively. *Oncotarget*., 9, 26299–308.

Chithra, V., Leelamma, S. (2000). *Coriandrum sativum*—effect on lipid metabolism in 1,2-dimethyl hydrazine induced colon cancer. *J Ethnopharmacol*., 71, 457-463.

Christensen, R., Bartels, E. M., Altman, R. D., Astrup, A. and Bliddal, H. (2008). Does the hip powder of *Rosa canina* (rosehip) reduce pain in osteoarthritis patients? A meta analysis of randomized controlled trials. *Osteoarthritis and Cartilage*, 16, 965–972.

Chrubasik, C., Roufogalis, B. D., Müller-Ladner, U. and Chrubasik, S. (2008). A systematic review on the *Rosa canina* effect and efficacy profile. *Phytotheraphy Research*, 22, 725–733.

Cotter, K., Konety, B., Ordonez, M. A. (2016). Contemporary management of prostate cancer. *F1000 Fac Rev*., 5, 1-8.

Custódio, L., Escapa, A. L., Fernandes, E., Fajardo, A., Aligué, R., Alberício, F., Neng, N. and Nogueira, J. M. F. (2011). In vitro cytotoxic effects and apoptosis induction by a methanol leaf extract of carob tree (*Ceratonia siliqua* L.). *Journal of Medicinal Plant Research*, 5, 1987–1996.

Custódio, L., Fernandes, E., Escapa, A. L., Aligué, R., Alberício, F. and Romano, A. (2009). Antioxidant activity and in vitro inhibition of tumor cell growth by leaf extracts from the carob tree (*Ceratonia siliqua* L.). *Pharm. Biol.*, 47, 721-728.

Czinner, E., Hagymási, K., Blázovics A., Kery, A., Szoke, A. and Lemberkovics, E. (2000). In vitro antioxidant properties of *Helichrysum arenarium* (L.) Moench. *J. Ethnopharmacol.*, 73, 437-443.

Darwish, R. M., Aburjai, T. A. (2010). Effect of ethnomedicinal plants used in folklore medicine in Jordan as antibiotic resistant inhibitors on *Escherichia coli*. *BMC Complement Altern. Med*., 10, 1.

Demir, F. and Ozcan, M. (2001). Chemical and technological properties of rose (*Rosa canina* L.) fruits grown wild in Turkey. *Journal of Food Engineering*, 47, 333–336.

Demir, S., Aliyazicioglu, Y., Turan, I., Misir, S., Mentese, A, Ozer-Yaman, S., Akbulut, K., Kilinç, K. and Deger, O. (2016). Antiproliferative and proapoptotic activity of Turkish propolis on human lung cancer cell line. *Nutr Cancer*, 68, 165–172.

Demir, S., Turan, I. and Aliyazicioglu, Y. (2016). Selective cytotoxic effect of *Rhododendron luteum* extract on human colon and liver cancer cells. *J. BUON*, 21, 883–888.

Deveci, E., Cayan, G. T., Karakurt, S. and Duru, M. E. (2020). Antioxidant, Cytotoxic, and Enzyme Inhibitory Activities of *Agropyron repens* and *Crataegus monogyna* Species. *Eur. J. Biol.*, 79, 98–105.

Edwards, J. E., Brown, P. N., Talent, N., Dickinson, T. A. and Shipley, P. R. (2012). A review of the chemistry of the genus Crataegus. *Phytochemistry*, 79, 5-26.

Elmas, L., Secme, M., Mammadov, R., Fahrioglu, U. and Dodurga, Y. (2019) The determination of the potential anticancer efects of Coriandrum sativum in PC-3 and LNCaP prostate cancer cell lines. *J. Cell Biochem.*, 120, 3506–3513.

Ercisli, S. (2007). Chemical composition of fruits in some rosa (*Rosa* spp) species. *Food Chemistry*, 104, 1379–1384.

Eroğlu, H. E., Hamzaoğlu, E., Aksoy, A., Budak, Ü. and Albayrak, S. (2010). Cytogenetic effects of *Helichrysum arenarium* in human lymphocytes cultures. *Turk. J. Biol.*, 34, 253–259.

Farhan, H., Rammal, H., Hijazi, A., Hamad, H., Daher, A., Reda, M. and Badran, B. (2012). In vitro antioxidant activity of ethanolic and aqueous extracts from crude *Malva parviflora* L. grown in Lebanon. *Asian Journal of Pharmaceutical and Clinical Research*, 5, 234–238.

Frankfurt, O. S. and Krishan, A. (2003). Apoptosis-based drug screening and detection of selective toxicity to cancer cells. *Anticancer Drugs*, 14, 555-561.

Gan, L., Zhang, S. H., Yang, X. L. and Xu, H. B. (2004). Immunomodulation and antitumor activity by a polysaccharide-protein complex from *Lycium barbarum*. *Int. Immunopharmacol.*, 4, 563–569.

Gao, X. M., Xu, Z. M. and Li, Z. W. (2000). *Traditional Chinese Medicines.* People's Health Publishing House, Beijing.

Gomez-Flores, R., Hernández-Martínez, H., Tamez-Guerra, P., Tamez-Guerra, R., Quintanilla-Licea, R., Monreal-Cuevas, E., Rodríguez-Padilla, C. (2010). Antitumor and immunomodulating potential of *Coriandrum sativum*, *Piper nigrum* and *Cinnamomum zeylanicum*. *Journal Nat Prod*., 3, 54-63.

Graf, B. L., Poulev, A., Kuhn, P., Grace, M. H., Lila, M. A. and Raskin, I. (2014). Quinoa seeds leach phytoecdysteroids and other compounds with anti-diabetic properties. *Food Chem.*, 163, 178–185.

Hossen, M. J., Kim, S. C., Son, Y. J., Baek, K. S., Kim, E., Yang, W. S., Jeong, D., Park, J. G., Kim, H. G., Chung, W. J. and Yoon, K. (2015). AP-1-targeting anti-inflammatory activity of the methanolic extract of *Persicaria chinensis*. *Evid. Based Complement Alternat. Med.*

Hussain, S., Malik, F., Khalid, N., Qayyum, M. A. and Riaz, H. (2012). Alternative and traditional medicines systems in Pakistan: History, regulation, trends, usefulness, challenges, prospects and limitations. *A Compendium of Essays on Alternative Therapy*, Dr. Arup Bhattacharya (Ed.), ISBN: 978-953-307-863-2, In Tech

Ilyasoğlu, H. (2014). Characterization of rosehip (*Rosa canina* L.) seed and seed oil. *International Journal of Food Properties*, 17, 1591–1598.

Inocencio, C. D., Rivera, F., Alcaraz, A. and Tomas, B. (2000). Flavoniod content of Commercial capper (*C. spinosa* L., *C. sicula andorientalis*) produced in Mediterranean countries. *Euro Food Res. Technol.*, 212, 70-4.

Jimenez, S., Gascon, S., Luquin, A, Laguna, M., Ancin-Azpilicueta, C. and Rodrıguez-Yoldi, M. J. (2016). *Rosa canina* extracts have anti-proliferative and antioxidant effects on Caco-2 human colon cancer. *PLoS One*, 11, e0159136.

Kilinc, K., Demir, S., Turan, I., Mentese, A., Orem, A., Sonmez, M., and Aliyazicioglu, Y. (2020). *Rosa canina* extract has antiproliferative and proapoptotic effects on human lung and prostate cancer cells. *Nutrition and Cancer*, 72(2), 273–282.

Kim, H. H., Park, K. H., Kim, M. H., Oh, M. H. and Kim, S. R. (2013). Antiproliferative effects of native plants on prostate cancer cells. *Nat. Prod. Sci.*, 19, 192–200.

Li, Q. Y. (2001). *Healthy Functions and Medicinal Prescriptions of* Lycium barbarum (Gou Qi Zi). Jindun Press, Beijing.

López-Lázaro, M. (2002). Flavonoids as anticancer agents: Structure–activity relationship study. Current Medicinal Chemistry. *Anti-Cancer Agents*, 2, 691–714.

Lu, H. S., Zhang, H. M. and Zhang, B. (2002). Proliferation and apoptosis of *Lycium barbarum* polysaccharides on human lung cancer PG cells. *J. Ningxia Med. Coll*., 24, 10–11.

Luo, Q., Li, Z. L., Huang, X. L., Yan, J., Zhang, S. H. and Cai, Y. Z. (2006). Lycium barbarum polysaccharides: Protective effects against heatinduced damage of rat testes and H_2O_2-induced DNA damage in mouse testicular cells and beneficial effect on sexual behavior and reproductive function of hemicastrated rats. *Life Sci.*, 79, 613–621.

Luo, Q., Li, Z., Yan, J., Zhu, F., Xu, R. J. and Cai, Y. Z. (2009). *Lycium barbarum* polysaccharides induce apoptosis in human prostate cancer cells and inhibits prostate cancer growth in a xenograft mouse model of human prostate cancer. *Journal of Medicinal Foods*, 12, 695−703.

Marmol, I., Sanchez-de-Diego, C., Jimenez-Moreno, N., Ancın-Azpilicueta, C. and Rodrıguez-Yoldi, M. J. (2017). Therapeutic applications of rose hips from different *Rosa* species. *IJMS*, 18, 1137.

Muhammad, G., Hussain, M. A., Jantan, I. And Bukhari, S. N. A. (2016). *Mimosa pudica* L., a high-value medicinal plant as a source of bioactives for pharmaceuticals. *Comp. Rev. Food Sci. Food Saf.*, 15, 303–315.

Naghibi, F., Irani, M., Hassanpour, A., Pirani, A. and Hamzeloo-Moghadam, M. (2014). Cytotoxic effects of selective species of caryophyllaceae in Iran. *Res J Pharmacognosy*, 1, 29–32.

Nasir, S., Batool, M., Hussain, S. M., Nasir, I., Hafeez, F. and Debboun, M. (2015). Bioactivity of oils from medicinal plants against immature stages of Dengue mosquito Aedes aegypti (Diptera: Culicidae). *Int. J. Agric. Biol.*, 17, 843–847.

Nazar, S., Hussain, M. A., Khan, A., Muhammad, G. and Tahir, M. N. (2020). Capparis decidua Edgew (Forssk.): A comprehensive review of its traditional uses, phytochemistry, pharmacology and nutrapharmaceutical potential. *Arabian J. Chem.*, 13 (1), 1901–1916.

Nelson, W. G., De Marzo, A. M. and Isaccs, W. B. J. A. C. (2003). Prostate cancer. *N Engl J Med*. 349, 366–381.

Paul, S., Sengupta, S., Bandyopadhyay, T. K. and Bhattacharyya, A. (2012). Stevioside induced ROS-mediated apoptosis through mitochondrial pathway in human breast cancer cell line MCF-7. *Nutr. Cancer*., 64, 1087–94.

Peteliuk, V., Rybchuk, L., Bayliak, M., Storey, K. B. and Lushchak, O. (2021). Natural sweetener *Stevia rebaudiana*: Functionalities, health benefits and potential risks. *EXCLI J*. 20, 1412–1430.

Philippou, V., Hadjipavlou, M., Khan, S., Rane, A. (2013). Complementary and alternative medicine (CAM) in prostate and bladder cancer. *BJU Int*., 112, 1073-1079.

Rahnavard, R. and Razavi, N. (2016). A review on the medical effects of *Capparis spinosa* L. *Advanced Herbal Medicine*, 2, 44–53.

Ranjbar, T., Nekooeian, A. A., Tanideh, N., Koohi-Hosseinabadi, O., Masoumi, S. J., Amanat, S., Azarpira, N., & Monabati, A. A comparison of the effects of Stevia extract and metformin on metabolic syndrome indices in rats fed with a high-fat, high-sucrose diet. *J. Food Biochem*., 44, e13242.

Rao, A., Vapiwala, N., Schaeffer, E. M. and Ryan, C. J. (2019). Oligometastatic prostate cancer: a shrinking subset or an opportunity for cure? *Am. Soc. Clin. Oncol. Educ. Book*, 39, 309–20.

Rates, S. M. K. (2001). Plants as source of drugs. *Toxicon.*, 39, 603–613.

Razavi, N., Molavi Choobini, Z., Salehian-Dehkordi, M., Saleh Riyahi, S., Salehian-Dehkordi, M. and Molavi Choobini, S. (2016). Overview of the antibacterial properties of essential oils and extracts of medicinal plants in Iran. *J. Shahrekord Univ. Med. Sci.*, 17, 41-52.

Reed, J. C. (2001). Apoptosis-regulating proteins as targets for drug discovery. *Trends Mol. Med*., 7, 314-319.

Repo-Carrasco, R., Espinoza, C. and Jacobsen, S. E. (2003). Nutritional Value and Use of the Andean Crops Quinoa (*Chenopodium quinoa*) and Kañiwa (*Chenopodium pallidicaule*). *Food Rev. Int.*, 19, 179–189.

Rodrigues, S., Calhelha, R. C., Barreira, J. C. M., Duenas, M., Carvalho, A. M., Abreu, R. M. V., Santos-Buelga, C. and Ferreira, I. C. F. R. (2012). *Crataegus monogyna* buds and fruits phenolic extracts: growth inhibitory activity on human tumor cell lines and chemical characterization by HPLC -DAD-ESI/MS. *Food Res. Int.*, 49, 516-523.

Roman, I., Stanila, A. and Stanila, S. (2013). Bioactive compounds and antioxidant activity of *Rosa canina* L. biotypes from spontaneous flora of Transylvania. *Chem. Cent. J.* 7, 73.

Russell, W. and Duthie, G. (2011). Plant secondary metabolites and gut health: a case study for phenolic acids. *Proc. Nutr. Soc.*, 70, 389– 396.

Sakar, E., El Yamani, M., Boussakouran, A., Ainane, A., Ainane, T., Gharby, S. and Rharrabti, Y. (2021). Variability of oil content and its physicochemical traits from the main almond [*Prunus dulcis* Mill. DA Webb] cultivars grown under contrasting environments in north-eastern Morocco. *Biocatal. Agric. Biotech*., 32, 101952.

Sathishkumar, P., Preethi, J., Vijayan, R., Yusoff, A. R. M., Ameen, F., Suresh, S., Balagurunathan, R., Palvannan, T. (2016). Anti-acne, antidandruff and anti-breast

cancer efficacy of green synthesised silver nanoparticles using *Coriandrum sativum* leaf extract. *J. Photochem. Photobiol. B Biol.*, 163, 69-76.

Shale, T. L., Stirk, W. A. and van Staden, J. (1999). Screening of medicinal plants used in Lesotho for anti bacterial and anti-inflammatory activity. *J. Ethnopharmacol.*, 67, 347–354.

Shen, Y., Zheng, L., Peng, Y., Zhu, X., Liu, F., Yang, X. and Li H. (2022). Physicochemical, antioxidant and anticancer characteristics of seed oil from three chenopodium quinoa genotypes. *Molecules*, 27, 2453.

Sheng, Z. Y., Guo, W. M. and Cheng, Y. (2002). Study on *Lycium barbarum* polysaccharides to adjust the apoptosis-related gene expression of T cells in old rats. *Chin. J. Immunol*., 18, 628–631.

Sozzi, G. O. and Vicente, A. R. (2006). Capers and caperberries. *Handbook of Herbs and Spices*. USA: Woodhead Pub..

Spencer, J. P. E., Mohsen, M. M. A. E. and Rice-Evans, C. (2004). Cellular uptake and metabolism of flavonoids and their metabolites: Implications for their bioactivity. *Archives of Biochemistry and Biophysics*, 423, 148–161.

Stone, N. N., Stock, R. G. (2002). Complications following permanent prostate brachytherapy. *Eur. Urol*., 41, 427–433.

Szentmihalyi, K., Vinkler, P., Lakatos, B., Illes, V. and Then, M. (2002). Rose hip (*Rosa canina* L.) oil obtained from waste hip seeds by different extraction methods. *Bioresource Technology*, 82, 195–201.

Tabata, M., Honda, G., Sezik, E. and Yesilada, E. (1993). A report on traditional medicine and medicinal plants in Turkey (1990, 1991). *Faculty of Pharmaceutical Sciences, Kyoto University*. Kyoto, 25, 116.

Tang, E. L. H., Rajarajeswaran, J., Fung, S. Y., Kanthimathi, M. S. (2013). Antioxidant activity of *Coriandrum sativum* and protection against DNA damage and cancer cell migration. *BMC Complement. Altern. Med*., 13, 347.

Tang, Y., Li, X., Zhang, B., Chen, P. X., Liu, R. and Tsao, R. (2015). Characterisation of phenolics, betanins and antioxidant activities in seeds of three Chenopodium quinoaWilld. genotypes. *Food Chem.*, 166, 380–388.

Turan, I., Demir, S., Kilinc, K., Aliyazicioglu, Y., Alver, A., Misir, S., Yaman, S. O., Akbulut, K., Mentese, A., & Deger, O. (2017). Morus rubra extract induces G1 cell cycle arrest and apoptosis in human lung and prostate cancer cells. *IJPER*, 51, 51–58.

Turan, I., Demir, S., Kilinc, K., Ozer Yaman, S., Misir S, Kara, H., Genc, B., Mentese, A., Aliyazicioglu, Y. and Deger, O. (2018). Cytotoxic effect of *Rosa canina* extract on human colon cancer cells through repression of telomerase expression. *J. Pharm. Anal. 8*, 394–399.

Vega-Galvez, A., Miranda, M., Vergara, J., Uribe, E., Puente, L. and Martinez, E. A. (2010). Nutrition facts and functional potential of quinoa (Chenopodium quinoaWilld.), an ancient Andean grain: A review. *J. Sci. Food Agric*., 90, 2541–2547.

Venskutonis, P. R. (2018). Phytochemical composition and bioactivities of hawthorn (*Crataegus* spp.): a review of recent research advances. *J. Food Bioact*., 4, 69-87.

Wang, L., Martins-Green, M. (2014). Pomegranate and its components as alternative treatment for prostate cancer. *Int J Mol Sci*., 15, 14949-14966.

Watt, J. M. and Breyer-Brandwijk, M. G. (1962). The medicinal and poisonous plants of southern and eastern Africa: being an account of their medicinal and other uses, chemical composition. In: *Pharmacological Effects and Toxicology in Man and Animals*. E and S Livingstone (Ltd.) London.

Wenzig, E. M., Widowitz, U., Kunert, O., Chrubasik, K, Bucar, F., Knauder, E. and Bauer, R. (2008). Phytochemical composition and in vitro pharmacological activity of two rose hip (*Rosa canina* L.) preparations. *Phytomedicine*, 15, 826–835.

WHO, (2009). *Diarrhea: why children are still dying and what can be done?* World Health Organization, Geneva.

Xiong, L. S. (2008). Pay attention to prostatic carcinoma. *Mod. Diagn. Treat*., 6, 123–124.

Xue, J. X., Chen, K. M., Hu, H. Y. and Gopinath, S. C. B. (2021). Progress in gene therapy treatments for prostate cancer, *Biotechnol. Appl. Bioc.*

Yang T, Wang C, Liu H, Chou G, Cheng X, Wang Z. A new antioxidant compound from *C. spinose* L. *Pharm Biol*. 2010; 48(5): 589-94.

Zamiri-Akhlaghi, A., Rakhshandeh, H., Tayarani-Najaran, Z. and Mousavi, S. H. (2011). Study of cytotoxic properties of *Rosa damascena* extract in human cervix carcinoma cell line. *Avicenna J. Phytomed.*, 1, 74–77.

Zhang, C. R., Dissanayake, A. A., Kevseroğlu, K. and Nair, M. G. (2015). Evaluation of coriander spice as a functional food by using in vitro bioassays. *Food Chem*., 167, 24-29.

Zhang, M., Chen, H., Huang, J., Zhong, L., Zhu, C. P. and Zhang, S. H. (2005). Effect of *Lycium barbarum* polysaccharide on human hepatoma QGY7703 cells: inhibition of proliferation and induction of apoptosis. *Life Sci*., 76, 2115–2124.

Zhou, H., Jian, R., Kang, J., Huang, X., Li, Y., Zhuang, C., Yang, F., Zhang, L., Fan, X., Wu, T. and Wu, X. (2010). Anti-inflammatory effects of caper (*C. spinosa* L.) fruit aqueous extract and the isolation of main phytochemicals. *J. Agric. Food Chem.*, 58, 12717-21.