12 Dandelion

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Abstract

Dandelion is prominently known as a weed. Several records have revealed its existence to live on a global basis. Dandelion acts as an excellent diuretic as well as blood and liver cleanser. It imparts numerous health benefits such as protection from ailments such as anaemia, liver cirrhosis and rheumatism apart from acting as potent anticancerous and anti-coagulatory agent. It grows on temperate regions of the world, along the roadsides, banks and prominently in areas with damp soils. The leaves of dandelion have received tremendous attention from researchers owing to the various chemical and pharmacological properties exhibited by them. It works as a folk medicine for the treatment of boils, fever and sore throat.

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Dandelion has shown widespread adaptability by surviving in manifold conditions. It has been also reported to exhibit anti-inflammatory and antioxidant properties which are attributed mainly to phenolics that are mainly more concentrated in the leaves than in the roots. There is sufficient data which have highlighted the significance of extracts from various species of dandelion such as *Taraxacum officinale*, *Taraxacum coreanum* and *Taraxacum mongolicum* to be utilized as an anti-inflammatory.

Keywords

Dandelion · Antioxidant activity · Anti-inflammatory · Anticancerous · Health benefits

Botanical name/common name – *Taraxacum officinale/*dandelion

12.1 Introduction

The word ‘dandelion’ is derived from the French term ‘dent de lion’, which means teeth of the lion, signifying the teeth-shaped edges of the leaves (Yarnell and Abascal 2009). Plant historians believe that the nativity of dandelion is shared between the Mediterranean section along with ancient Greeks, Romans and Egyptians (Abulafia 2011). Persians identified dandelion as tarashquq around 900 AD. After a few decades, the name got altered to taraxacum. The common name of this plant is based on the petals of the flower which resemble the canines of a lion, which in French is translated as ‘dents de lion’ and later modified as ‘dandelion’ (Allaby 2010). The earliest discovery of dandelion took place in North America with the Vikings (Stewart-Wade et al. 2002).

Dandelion is recorded to have its fossil seeds in Places of south Russia. The first ever documented records of dandelion are between the tenth and eleventh centuries by ancient Romans and Anglo-Saxons followed by the Europeans during the thirteenth century (Coates 2013). Between the tenth and eleventh centuries, dandelions are mentioned for medicinal objectives by Arabian physicians. The ethnic population of North America also utilized dandelion in their conventional therapeutic procedures. Being a common plant, dandelion is observed widely around, and in India, it was observed in the Himalayas and has been used for its herbal potential against liver disorders and as diuretics (Tabassum et al. 2010). Dandelion has gathered exciting labels all through the past including ‘pee in the bed’, ‘swine snout’ and ‘witch’s milk’ for their diuretic property. Greek botanist Theophrastus between 371 BCE and 287 BCE has suggested dandelion’s tonic, particularly to fight blotches and liver-coloured freckles on the skin surface (Mars 2016). Persian physician, theorist and researcher Abu Ali Sino, well-known as Avicenna, testified that milk extract from dandelion retains positive impacts in lessening the signs of glaucoma (Sharifi-Rad et al. 2018). Dandelion is additionally designated as a plant with high medicinal values by Ortus Sanitatis in 1485 at European herbal. Meanwhile, throughout both the world wars, it was a resource of nutrition, while several individuals experienced nutritive inadequacies. Since 1930, studies about dandelion have been concentrated on the assessment of its pharmacological potential and biochemical characteristics on human biology (Martinez et al. 2015). Dandelion retained a position in the United States National Formulary from 1888 to 1965, and the dried up root of dandelion plant is recorded in the United States Pharmacopoeia.

12.1.1 Production (India, World)

Dandelion being an edible plant has its widespread abundance in the temperate zones with warm climate of the northern hemisphere (Jinchun and Jie 2011). Dandelions grow well on lands high in nitrogen and potassium. Also, lands low in calcium or soil with inadequate decomposition of organic material are suitable for the growth of this crop (Kuusi et al. 1984). They are herbaceous crops that grow well in humid, warm regions observed in more parts of the northern temperate region and also have the ability to survive in a variety of climates. On the contrary, dandelion cannot be cultivated on soils rich in phosphorus.

Dandelion is regularly cultivated by relocating and is uniformly spread out in rows since it occupies more space while growing (Martin and Leonard 1949). This also facilitates the seedlings to be less competitive with the already emerged crops. Being a perennial wildflower, dandelion creates a sturdy taproot with a usual length of up to 15–30 cm. Immature dandelion shoots are planted and bedded into compost soil (Petlevski et al. 2003). The blooms grow up from the highest vicinity of the root where a stiff crown is created. The roots of dandelion plant have several hairlike rootlets. Though the dandelion is cut back beneath the soil surface, the residual tubers will be able to produce new plants. Generally, an average of 14,000–15,000 seeds will be generated per dandelion plant. The seeds per flower range between 150 and 200 in numbers, and up to 10 flowers can be cropped out per plant (Bretzel et al. 2014).

For large scale production of dandelion's leaves, they are frequently grown-up as a transplant and are placed in uniformly spaced rows. To produce roots, dandelion sowing is done directly in the first part of spring. Roots are of their finest quality and size at about 2 years' post-sowing period (Eggert et al. 2018). All sections of the plant are consumable and are utilized for therapeutic and culinary objectives. The roots and leaves can be dried up and processed for use therapeutically, the blooms can be produced into dandelion wine, and the young leaves can be consumed fresh in salad, while the matured ones are used in cooking (Tierra 1998).

The initial evidences related to the origin of dandelion pertain to Europe, Asia and North America which leads to the difficulty in determining its exact indigenous environment (Tarlo 2017). Dandelion is one of those plants with immense medicinal attributes which is grown and cultivated naturally in Europe, North and South America and Asia (Qureshi et al. 2017). The distribution of dandelion is observed in Central and South America along with Australia as well as New Zealand (Mingarro et al. 2015). The most prominent reasons for its production are for medicinal uses as well as for food applications (Wirngo et al. 2016). Dandelion was also used by North Americans, Ojibwa and Rappahannock tribe for medicinal purposes on traditional basis (Tarlo 2017). The major countries which are known for the cultivation and production of dandelion are Bulgaria, Romania, Hungary and Poland (Brock 2004). The common areas where dandelion can be traced out lie in the tropics, in highlands having altitudes and cool climate and in temperate zones with hot climate in the northern hemisphere (Wirngo et al. 2016).

12.1.2 Botanical Description

Taraxacum officinale is a milk-conveying perennial herb lacking stem. It is considered as a herb from the family Asteraceae and tribe Lactuceae which can attain a height of 0.5 m (Bashmakov et al. 2008) or even 2 m (Stewart-Wade et al. 2002). The stems are extremely low in length (1.25 cm approx.) along with much shorter internodes located at or under the soil (Gier and Burress 1942). The leaves of dandelion show huge variations with respect to shape and colour with covering of hairs on the outer surface responding rapidly to water, nutrients and exposure. It has flowers with golden yellow colour embedded on empty stems emerging from the centre of the rosette (Fatima et al. 2018).

The leaves of dandelion are generally 5–40 cm and 0.7–15 cm in length and breadth, respectively, reducing in thickness towards the petiolar base with wings (Holm et al. 1997). The roots of dandelion become short in length and move deep inside the soil for protection (Ianovici 2016). Dandelion is stemless having extremely short internodes along with a roselike arrangement of leaves at the base region (Lis et al. 2018). The lateral roots in two different rows intertwine in a spiral fashion in a clockwise manner around the root with their distribution along the entire length (Gier and Burress 1942).

Dandelion has leaves which have deep teeth without hairs with a length of 5–30 cm and breadth of 1–10 cm (Fatima et al. 2018). It has a well-developed tap root system whose length goes up to 0.5 m (Bashmakov et al. 2008). The roots are brown on the outer side whereas white on the inner side with fleshy texture prone to breakage (Fatima et al. 2018). The flowers are capable of growing up to a diameter ranging between 7 and 15 mm (Tarlo 2017).

The fruit of dandelion closely looks like olive-brown achenes along with a white clump of fibres increasing the surface area resulting in flight (Bashmakov et al. 2008). The taproots of dandelion are dark brown in colour with a solid appearance which can go deep into the soil up to 10–15 feet (Hourdajian 2006).

12.2 Characterization of the Chemical Compound(s) Responsible for Antioxidant Properties

12.2.1 Bioactive Components and Their Antioxidant Properties

Diverse health benefits of dandelion are attributed to a wide range of bioactive molecules distributed in their tissues (leaf, flower, root, skin) which mainly include terpenes, flavonoids and phenolic compounds. Sesquiterpene lactones taraxacin and taraxacerin (Leung et al. 1996) impart bitterness to the plant. Triterpenoids like cycloartenol, taraxasterol and Ψ-taraxasterol are distributed in their tissues (Cordatos 1992). Flavonoid glycosides including luteolin 7-glucoside, luteolin 7-O-rutinoside, isorhamnetin 3-O-glucoside and apigenin 7-O-glucoside have been isolated and identified from its flowers and leaves using chromatographic methods, and the only quercetin 7-O-glucoside was identified from inflorescences and leaves (Fatima et al. 2018; Wolbis et al. 1993).

Additionally other sesquiterpenes, namely, tetrahydroridentin B and taraxacolide-*O*-β-glucopyranoside; the guaianolides 11β,13-dihydrolactucin and ixerin D; three germacranolide esters, taraxinic acid β-glucopyranoside, its 11,13-dihydroderivative and ainslioside; and various triterpenes, their acetates and 16-hydroxy derivatives were also identified (Kisiel and Barszcz 2000; WHO 2007; Gonzalez-Castejon et al. 2012). Hydroxycinnamic acids, chicoric acid, monocaffeyl tartaric acid and chlorogenic acid are prevalent in the plant, whereas the leaf extracts are a main source of coumarins, cichoriin and aesculin (Williams et al. 1996).

In addition to this, other terpene components such as beta-amyrin, free sterols, phenylpropanoids, triterpenoid saponins and polysaccharides such as fructosans and inulin were also identified. Complex carbohydrates such as pectin and resins were also identified. Williams et al. (1996) isolated and identified cinnamic acid, coumarins and flavonoids from *T. officinale* plant by using various analytical methods.

Diaz et al. (Díaz et al. 2018) examined the hexane extract and characterized lupeol acetate, betulin, lupeol, 3,7,11,15-tetramethyl-2-hexadecen-1-ol, diethyl phthalate and phytol. On the other hand, 80 components were identified in the ethyl acetate extract. Several studies have reported that the dandelion extracts showed potential antioxidative activity as examined in food and biological models with the antioxidant potential mainly associated with the substituted amount and position of hydroxyl groups (Teissedre et al. 1996; Hu and Kitts 2005; Liao and Yin 2000). Components responsible for this property are found to be ascorbic acid, flavonoids and coumaric acid. The extracts of the leaves have the potential enough to donate hydrogen and scavenge hydrogen peroxide as well (Hagymasi et al. 2000; Wolbis et al. 1993).

It was also reported that the leaf and root extracts of dandelion have hydrogen-donating, ROS formation-inhibiting and radical-scavenging activities. Another major study revealed that in the case of dandelion flower extracts, ethyl acetate fraction imparted protection to DNA from ROS-induced damage by scavenged ROS. Oxidative stress was also prevented due to the bioactive components such as luteolin and luteolin 7-O-glucoside (Hagymasi et al. 2000). Hu and Kitts (2005) reported the flower extracts of dandelion inhibited hydroxyl-radicals which was attributed to the phenolic components such as caffeic acid, chlorogenic acid, luteolin and luteolin 7-glucoside.

12.3 Health Benefits

In accordance with literature survey, *Taraxacum officinale* has been recognized for its medicinal and nutritive value due to the presence of several bioactive compounds such as terpenes, flavonoids, alkaloids, saponins, steroids and phenolic substances (Mir et al. 2013). Dandelion has been predominantly known to Asia, Europe and North America and is widely utilized in various conventional as well as current herbal medicines. The plant is incorporated in folk medicines of India, China and Russia for the treatment of various liver diseases and some female disorders such as uterine and breast cancer. In China, the therapeutic value of dandelion was combined with other herbs to cure hepatitis. The plant is also used to prevent respiratory tract infection, jaundice, toxicity, fever, eye problems, eczema, anaemia and pneumonia (Blumental et al. 2000; Mahesh et al. 2010).

The nutritional value of dandelion roots comprises of carbohydrates (inulin); vitamins; carotenoids (lutein); fatty acids (myristic acid); hexose sugars like glucose, sucrose and fructose; choline; mucilage; and pectin. About 45% of roots contained inulin, a fructo-oligosaccharide complex, which may be helpful in abolition of pathogens present in the gastrointestinal tract, suppression of obesity, prevention of osteoporosis and tumour regression (Roberfroid 1999). The leaf extracts are recognized to be highly effective against obesity and cardiovascular disorders (Choi et al. 2010).

In addition, dandelion is reported to be a storehouse of many bioactive compounds such as sesquiterpene, lactones, taraxerol, taraxasterol and chicoric and chlorogenic acids. These harmless and non-toxic components are reported to exhibit antioxidative, antidiabetic, anti-inflammatory, antirheumatic and chloretic activities (Arpadjan et al. 2008). The research work concerning the interesting components like taraxerol and taraxasterol is scanty, though these components are present in greater amounts in dandelion as compared to other plants (Sharma and Zafar 2014). It is also a rich source of many vitamins particularly vitamins A, C, E, D and B and minerals especially iron, zinc, copper, manganese, sodium, potassium, magnesium, calcium, silicon and phosphorous. Minerals like iron and calcium are found to be in higher concentrations as compared to that in spinach (Ali 1989; Ata et al. 2011). The mobility of ions like calcium may assist to arouse the exocytosis of insulin (Komatsu et al. 1997).

Dandelion is acknowledged as the richest source of β-carotene (11,000 μg/100 g leaves) which is almost equivalent to that carrot (Mir et al. 2015). In the study of Khoo et al. (2011), it was presented that β-carotene contained in dandelion provides protection against oxidation and cellular damage. More recently, chicoric acid, with polyphenolic content of 34.08 ± 1.65 g/Kg, is recognized as the most plentiful constituent of dandelion. The flowers and leaves are found to have greater concentration of polyphenolics in comparison to the stem (Williams et al. 1996; Fraisse et al. 2011; Kenny et al. 2015).

Among the common metabolic disorders, diabetes is characterized by high blood pressure; artery blockage; heart diseases; imbalanced carbohydrate, lipid and protein metabolism; and also abnormality in pancreas functionality (Mutalik et al. 2003; Abdul-Ghani et al. 2006). This metabolic disorder might occur due to imbalance in secretion as well as activity of insulin and glucagon hormones, which in turn may cause enhancement in plasma glucose levels and distraction of natural processes in the liver, pancreas, skeletal muscle tissue, adipose tissue, nervous system and gut. The interruption in natural phenomenon leads to irregularity in glucose homeostasis, which has significant role in the occurrence of this endocrine multifactorial ailment (Scheen 2003). Other symptoms of diabetes may include renal malfunctioning and blindness, which are most important risk factors for cardiovascular heart diseases.

Literature studies demonstrated that traditional medication including the utilization of bioactive plants can possibly mitigate diabetic side effects, empower recuperation and improve well-being (Marles and Farnsworth 1995). In spite of generous advancement in treatment of diabetes by oral hypoglycaemic agents, investigations for newer medicines proceed in light of the fact that the current synthetic drugs have a few constraints and destructive impacts. Natural drugs have been utilized and asserted as antidiabetic agents, yet exceptionally less are accessible on economically figured structures (Ghazanfar et al. 2014).

Nnamdi et al. (2012) evaluated the antidiabetic potential of dandelion leaf and root in streptozotocin (STZ)-induced diabetic rats. It was demonstrated that both roots and leaves exhibit hypoglycaemic effect, but the roots are reported to be more beneficial in treating diabetes. The antidiabetic potential of dandelion might be due to binding of tannins with amylase enzyme. This association reduces the digestive activity of amylase, and ultimately digestion of carbohydrates slows down, which results in lowering of glucose levels in blood. Tannins are also reported to have binding ability to glucose molecules, thus reducing their availability for absorption in blood (Thompson 1993).

The alpha amylase and alpha glucoside inhibition potential of dandelion was studied by Mir et al. (2015) for evaluating the antidiabetic activity. Methanol and water extracts of roots, stem and flowers parts of dandelion were considered. Results of the study revealed that water extracts possess significant alpha amylase and alpha glucoside inhibition potential and thus antidiabetic activity in comparison to methanol extracts. The highest antidiabetic property was exhibited by stem, while flowers possess the least antidiabetic activity. It was also documented that inulin, a fructo-oligosaccharide complex, existing in roots of dandelion is recognized for lowering hyperglycaemia as well as normalization of blood sugar levels. The mechanism for reducing hyperglycaemia might involve binding of inulin with the molecules of glucose, leading to increased glucose absorption after the digestion process (Yarnell and Abascal 2009).

The antimicrobial potential of dandelion leaves was demonstrated by Diaz et al. (2018). In their study, the phytochemical constitution and biological properties of n-hexane and ethyl acetate extracts of dandelion leaves were explored. Both extracts were reported to have significant amounts of triterpenoids and fatty acids mainly palmitic and linolenic acids. The results of the study propose that both extracts inhibit the activity of uropathogenic bacteria. Therefore, the dandelion leaf extracts could be utilized in the production of future products with industrial relevance.

The effectiveness of dandelion root extract against drug-resistant human melanoma cells was investigated by Chatterjee et al. (2011). They reported that root extracts are highly active in regression of chemo-resistant skin cancer cells without causing any toxicity to healthier tissue and proposed that dandelion can be regarded as novel and natural chemopreventive agent.

The anti-inflammatory activity of leaves of *T. officinale* is reported to provide protection against cholecystokinin-induced severe pancreatitis in rats (Seo et al. 2005). The various constituents such as terpenoids, taraxacin and taraxacerin found in *T. officinale* are known to prevent gall bladder and liver disorders (Wirngo et al. 2016).

During biological processes such as autoxidation, oxidative phosphorylation and glycosylation, higher glucose may produce reactive oxygen species (ROS) in β-cells (Robertson et al. 2007). The excess production of these reactive substances may enhance the risk of various diseases. To overcome the degenerative effects of these chemical species, the need of antioxidants becomes vital. Literature studies revealed that plant materials are blessed with compounds having high antioxidant activity and are regarded as best source of potentially safer natural antioxidants. According to You et al. (2010), dandelion is recognized to have sufficient antioxidative activity to provide protection against the highly reactive degenerative species. The leaf extracts are highlighted for their hydrogen-donating, H_2O_2 scavenging and reducing abilities. Flowers are also acknowledged for high antioxidant potential due to the existence of significant amounts of phenolic compounds such as flavonoids and ascorbic and coumaric acids. The radical-scavenging capability and hydrogen-donating power of root and leaf parts of dandelion were demonstrated by Hagymasi et al. (2000). They also conclude that roots and leaves can inhibit the formation of highly reactive oxygen species to a greater extent.

In accordance with available literature, *Taraxacum officinale* (dandelion) has been widely used as antimicrobial, antioxidant, diuretic and digestive and insulin stimulant. It can be recognized as chief antidiabetic plant as it exhibits hypoglycaemic, antioxidant and anti-inflammatory activities. The therapeutic value of dandelion might be attributed to the various bioactive compounds like triterpenes, polyphenolic substances, sesquiterpenes, phytosterols and the most significant chicoric and chlorogenic acids. The other health promising effects such as anticancer, antisteatotic, hepatoprotective and antilipidemic have also been recognized. However, further research work concerning the bioavailability as well as metabolism of dandelion constituents is scanty and requires to be explored.

12.4 Conclusion

The taxonomy of *Taraxacum officinale* is complex. Its origin lies in Europe. The major reasons for its production are aimed at medicinal and food applications. Apart from this, dandelion is also regarded as an antidiabetic due to its anti-hyperglycaemic and antioxidative potential. Owing to various bioactive components in dandelion such as phenolic compounds, triterpenes and phytosterols, this plant has been able to gather ample attention from the research world. It can withstand drought as well as frosty weather. Dandelion does not hold the potential to remain in medicinal history but also a promising plant to be explored in the future.

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