Review paper

Quercus cerris L.: An Overview

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Abstract. The Turkey oak is a frequent tree species in the Mediterranean climate zones of southern Europe and Asia Minor. It has been used in the human diet, for medicinal purposes, firewood and charcoal production. Like all oaks, Turkey oak is suffering from dieback and decline owing to the combination of several detrimental factors, such as insects, diseases and unfavorable environment, leading to their deterioration and sometimes resulting in their early death.

Key words: *Quercus cerris* L., distribution, microorganisms, pests, diseases, pollution.

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Distribution of *Quercus cerris* L. and Physical Characteristics

The genus *Quercus*, commonly known as oak, is considered as one of the most dominant group of woody angiosperms in the northern hemisphere and is well evaluated for its economic importance and species diversity (Tantray *et al.*, 2017). Turkey oak is a member of this genus and naturally grows in southern Europe and Asia Minor (de Rigo *et al.*, 2016). Across its distribution range, it is notably found in England, France, Italy, the Balkan Peninsula, as well as Albania (Stafasani & Toromani, 2015). Turkey oak is also found in Lebanon where it constitutes 14% of broadleaved trees species (Figure 1). Table 1 represents the international common names of *Quercus cerris*.

■ *Quercus calliprinos* Webb ■ *Quercus infectoria* Olivier
■ *Quercus cerris* L. ■ *Ostrya carpinifolia* Scop
■ Other

Figure 1. Relative frequency of broadleaved tree species in Lebanon.

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Table 1. International common names of *Quercus cerris* L.

Language	Name	References
English	Turkey oak, Austrian oak, Bitter oak, Iron oak, Mossy-cupped oak	CABI, 2021 Burlacu et al., 2020
French	Chêne chevelu, chêne de Bourgogne, Chêne de Turkuie, Cerre	CABI, 2021
Arabic	Ezer	Lebanon Flora, 2013
Spanish	Marojo	CABI, 2021
Italian	Cerro, Serro	CABI, 2021

Turkey oak is a long-lived deciduous tree which loses its leaves at the end of its growing season. It can reach the height of 30–40 meters under favorable conditions with a trunk of up to 2 meters in diameter (de Rigo *et al.*, 2016). It has a thick, dull grey, deeply fissured bark (Figure 2) (Gilman & Watson, 1994). The grey twigs are gnarled and slightly pubescent with lenticels. The buds are ovoid, with long hairy stipules, and persistent twisted scales. The thick and rough dark green leaves of Turkey oak consist of 5 to 9 deep lobes and are generally between 9 and 12 cm in length and 3–5 cm in width (Figure 3). During autumn, the leaves eventually turn yellow and fall.

Turkey oak is a monoecious tree that bears both unisexual flowers and is typically wind pollinated in spring. The species produces widely known fruit, commonly identified as acorns that are approximately 3 cm long (Figure 4) and mature 18 months after pollination. It should be noted that the acorns are surrounded at the base by a hairy cup known as the cupule that holds and protects the fruit during its growth and maturation.

Figure 2. The bark shape of Turkey oak.

Figure 3. The dark green leaves of Turkey oak.

Figure 4. Acorns with a hairy cup.

Figure 5. Forest dominated by Turkey oak in North Lebanon.

Habitat and Ecology

Quercus cerris is considered as a Mediterranean oak tree which thrives under Mediterranean climatic conditions (Figure 5) (Bozzano & Turok, 2003; Di Iorio *et al.*, 2007). It is a hardy, fast-growing plant, relatively tolerant to frost, drought and salt, and can grow in most soil types, including clay, heavy clay, loam, acid, neutral, and alkaline soils (Gilman & Watson, 1994). Well-drained soil and full sun are best for its optimal growth and flowering. However, studies have pointed out that Turkey oak can survive in and adapt well to intense canopy conditions (Bobinac *et al.*, 2019).

In addition, *Quercus cerris* is considered as a pollution-tolerant tree (de Rigo *et al.*, 2016). Indeed, air pollution presents a global problem which does not only affect animals and humans but has many harmful impacts on plants, as well. Some of these effects are visible especially in leaf colors, shapes, width and petiole length.

While others are invisible like stomatal closure, decrease in transpiration rate and inhibition of photosynthetic activity (Rai, 2016; Saxena & Kulshrestha, 2016).

The responses of trees to pollution stresses vary widely among species. Some species are considered as sensitive while others are reported as tolerant plants accumulating pollutants in their bodies (Rai, 2016).

Tzvetkova and Kolarov (1996) showed in their study on four different tree species that *Quercus cerris*, growing in a region with significant industrial emissions, was the most tolerant to air pollution. In their study, it was observed that *Quercus cerris* leaves collected from polluted sites have accumulated large amounts of toxic elements, but simultaneously showed minor variations of carbohydrate concentration which demonstrated good tolerance and resistance of the species to air pollution and reinforced the idea of using it for afforestation of industrial areas.

Value of *Quercus cerris*

Turkey oaks are multifunctional trees enabling a wide range of goods and services. They offer not only environmental protection but also revenue and livelihood options for forest-dependent communities.

They are well known by their ability to grow in a broad range of soil conditions, making them useful in soil cover, reforestation and erosion prevention (Mert *et al.*, 2016).

Compared to other oaks, Turkey oak wood is less valued because of its susceptibility to split and its lower resistance and durability (Ferrari *et al.*, 2013). It is primarily used to make charcoal, for temporary constructions and firewood. Nowadays, Turkey oak wood is used for manufacturing wine barrels in Albania, because they impart flavor and color to the wine inside (Stafasani *et al.*, 2018).

The seeds of Turkey oak can have several uses. They can be dried, grounded into powder and used as thickening agents or mixed with cereals for making bread. Roasted seeds are used in the preparation of a coffee-like beverage (Pinto *et al.*, 2019).

Additionally, a sweet fluid (saccharine fluid) exudes from insect damage on the stems and solidifies. This saccharine secretion is edible and is sold in local markets in Kurdistan and Iran. In fact, this fluid is boiled down into a syrup and used in sweetening food or mixed with flour for making a cake (Hedrick, 1919).

Furthermore, Turkey oak acorns represent an important source of food for some wildlife. These fruits have been also described as containing high contents of tannins and therefore are strongly astringent (Vinha *et al.*, 2016).

Studies revealed that galls, barks and leaves are all rich in active compounds with antioxidant activity, such as tannins, and are therefore used in traditional medicine for numerous purposes, including the treatment of hemorrhages, dysentery, chronic diarrhea, and gum problems (Taib

et al., 2020).

Moreover, scientific reports have validated the use of *Quercus cerris* extracts against some pathogenic microorganisms. In fact, antimicrobial resistance is one of the serious problems the world is facing today since resistant pathogens develop resistance to drugs currently used for infectious diseases. In addition, many synthetic antimicrobial agents have side effects on human patients, including hypersensitivity and allergic reactions (Şöhretoğlu *et al.*, 2007; Smailagić *et al.*, 2020). For these reasons, the discovery of alternative drugs derived from natural resources is needed.

According to research, organic extracts of *Quercus cerris* acorns have antioxidant and antimicrobial properties, which could be explained by their richness in bioactive phenolic compounds, such as tannins and flavonoids (Vinha *et al.*, 2016).

Research showed also that the butanol extracts of *Quercus cerris* leaves exhibit antibacterial activity against *Staphylococcus aureus* and display good antifungal activity, especially against *Candida krusei* (Şöhretoğlu *et al.*, 2007; Hobby *et al.*, 2012). In addition, Smailagić *et al.* (2020) reported in their study that extracts of *Quercus cerris* wood could be used against the Methicillin-resistant *Staphylococcus aureus* (MRSA). The antimicrobial activity of these extracts could be attributed to their phenolic acid contents, including gallic and ellagic acid. Table 2 represents the minimum inhibitory concentration (MIC) of various *Quercus cerris* extracts on different pathogens.

Pests and Diseases

Similar to other oak species, the Turkey oak has suffered periods of decline, attributed to a variety of interacting biotic and abiotic causes (Amorini *et al.*, 1996; Gottschalk & Wargo, 1997; Colangelo *et al.*, 2018). It is usually attacked by the prevalent diseases of oaks which include oak mildew, oak wilt, chestnut blight, anthracnose, oak leaf

Table 2. Summarized MIC values for different *Quercus cerris* extracts obtained from literature data.

<i>Quercus cerris</i> extracts MIC (µg/mL)	<i>Sm</i>	<i>Sa</i>	<i>Sp</i>	MRSA	<i>Lm</i>	<i>Ca</i>	<i>Ck</i>	<i>Cp</i>	References
Leaf butanol extract	-	200	-	-	-	64	64	128	Hobby <i>et al.</i> , 2012 Şöhretoğlu <i>et al.</i> , 2007
Leaf ethyl acetate extract	-	-	-	-	-	128	64	128	Şöhretoğlu <i>et al.</i> , 2007
Leaf aqueous extract	-	-	-	-	-	128	64	128	Şöhretoğlu <i>et al.</i> , 2007
Stem/root butanol extract	-	200	-	-	-	-	-	-	Hobby <i>et al.</i> , 2012
Wood methanol extract	130	30	80	30	500	-	-	-	Smailagić <i>et al.</i> , 2020

Sm: *Streptococcus mutans*; *Sa*: *Staphylococcus aureus*; *Sp*: *Streptococcus pyogenes*; MRSA: Methicillin-resistant *Staphylococcus aureus*; *Lm*: *Listeria monocytogenes*; *Ca*: *Candida albicans*; *Ck*: *Candida krusei*; *Cp*: *Candida parapsilosis*; (-): not tested.

blister, and leaf spots (Ragazzi *et al.*, 2007; Marçais & Desprez-Loustau, 2014).

Powdery mildew of oak is a disease caused by different species of fungi which attack young leaves. It starts as little white spores usually on the lower leaves of the tree and then spread over the entire tree if left untreated. The spores cover the leaves and inhibit photosynthesis causing them to wilt and fall off. Early detection provides the best way to contain the spread of this disease. In most situations, fungicides are sprayed to prevent the fungi from stunting the growth of seedlings and young trees (Lonsdale, 2016; Lamp’l, 2021). The use of fungicides, although being strongly effective, might be impracticable in a forest situation where there is a large number of trees, or may be illegal in some countries (Lonsdale, 2016). Thus the use of an alternative treatment method is needed. One of the possibilities that could be investigated is the use of natural control agents, such as pathogens that can parasitize the oak powdery mildew fungi and eventually inhibit the formation of its spores.

Oak wilt is caused by *Ceratocystis fagacearum* which blocks the movement of water and nutrients in the xylem, causing the death of trees. Once an infection is established, the oak wilt fungus moves swiftly from the infected tree to adjoining ones through root grafts that exist between them. To contain the problem, trenches should be dug to a depth of at least three

feet between diseased and healthy oaks to minimize the root graft transmission of the fungus (Figure 6). Trenches should be installed approximately 100 feet from the infected tree that should be afterwards removed. Symptom-free oaks grown within the trench line should be protected by injecting trunks with a systemic fungicide to eliminate the possibility of disease spread (Wilson, 2005; Fite, 2018).

Figure 6. Trenches installed around the infected tree (Adopted from Fite, 2018).

Chestnut blight is actually a canker disease caused by a fungus, *Cryphonectria parasitica*. It attacks and damages the outer bark layer of oak trees but usually cannot affect the roots, because other microorganisms in soil impede the growth of the blight

fungus and eventually kill it. Researchers take advantages of this phenomenon and cure the diseased tree by packing soil over trunk cankers. This practice for combating blight canker is known as the soil compress method. The basics of this biological method are simple. It consists of taking soil from around the base of an infected tree and mixing it with water to cause it to become watery. A plastic sleeve is then wrapped around an existing canker with waterproof tape. After that, the plastic material should be filled at least two inches thick with the wet soil and secured at the top with tape or string to prevent the soil compress from drying. The compress should be extended at least one foot above and below the cankered area and retained in place for at least a couple of months (Figure 7) (Weidlich, 1978).

Figure 7. Soil compress plastered all over the canker (Adopted from Weidlich, 1978).

The soil compress method has been applied in Albania by a group of researchers to heal infected chestnut tree barks me-

chanically (Ndreu & Shehi, 2021). Briefly after cleaning the cankered area with a sickle, the muddy soil was plastered all over the cankerous wound and kept till the end of the growing season. Soil was collected from under the diseased tree and mixed with water and copper sulphate. The latter is an inorganic compound generally used to kill fungi and bacteria. This method differs from other traditional methods by cleaning the part affected by blight canker and then plastering the gooey mud. Tree cleaning allows the wood to start the recovery process of the cankerous wound and inhibits the spread of canker to other trees. The implementation of this method has enabled improvement of the condition of infected chestnut plantations, minimized their drying and enhanced their productivity. Therefore, application of this simple method to treat other infected trees, such as oaks, could be interesting.

A chemical method can also be applied to control chestnut blight disease. This method consists of spraying fungicides, such as copper oxychloride, copper sulphate and thiophanate methyl on the wound.

Anthrachnose disease is caused by many different fungi that create irregular-shaped brown lesions on leaves. As the disease gets worse, the tree branches can also become infected with the anthracnose fungus and start to crack. The management of anthracnose consists of pruning out the diseased branches and removing infected leaves and twigs. Trees may also be injected with systemic fungicides. Some applied fungicides can trigger the tree's natural defense mechanisms rendering it more tolerant to infection with faster recovery time; whereas others can directly kill the fungus itself and are recommended when the infection is particularly severe and recurs every year (Arborjet, 2020).

As for oak leaf blister, it is caused by the *Taphrina caerulescens* fungus. Cool wet weather favors this pathogen which produces brown blotches preceded by light

green blisters on the upper leaf surface. In severe infestation cases the tree may drop all of its leaves. In addition, Turkey oak is susceptible to *Discula quercina*, *Phomopsis quercina* and *Hypoxyton mediterraneum* fungi (Vannini *et al.*, 1996; Ragazzi, 2001; Moricca & Ragazzi, 2008). It can also be infected by pathogens such as the *Phytophthora* species, including *P. cinnamomi*, which flourish in winter climate conditions (Oh *et al.*, 2011).

Turkey oak is also attacked by a wide range of pests that cause damage to the tree, including scale, oak skeletonizer, leaf miner, oak lace bugs, borers, caterpillars, and nut weevils.

Conclusion

Turkey oak, growing in most soil types, is one of the most important resources providing multiple benefits to people. It is used in foods, traditional or folk healing practices and has showed antimicrobial properties against some human pathogenic microorganisms. However, further studies are needed to assess the antioxidant and antimicrobial activities of different tree parts against a broader range of pathogens in order to encourage its use in pharmaceutical industries. Furthermore, to fight environmental pollution that affects ecosystems in a number of ways, and since Turkey oak is considered as a pollution-tolerant tree species, it could be highly recommended for afforestation along roadsides and in industrial regions.

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