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Review

Genus *Ilex* L.: Phytochemistry, Ethnopharmacology, and Pharmacology

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ABSTRACT

The genus *Ilex* L. has been used as remedies in traditional Chinese medicine in Aquifoliaceae and beverages for thousands of years due to abundant pharmaceutical bioactivities. There are 600 species in genus *Ilex* L. containing various compounds such as terpenoids, saponins, glycosides, etc. Three species, *I. cornuta*, *I. chinensis*, and *I. rotunda* have been admitted in *Chinese Pharmacopoeia 2015* to treat dyspepsia, stomatitis, and hyperactivity cough and protect the liver and kidney. Recent studies showed that several species have been daily drunk to promote human health and prevent cardiovascular diseases in the folk. Here we reviewed the genus *Ilex* L. in phytochemistry, ethnopharmacology, and pharmacology.

Key words

Aquifoliaceae; ethnopharmacology; *Ilex* L.; pharmacology; phytochemistry; traditional Chinese medicines

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1. Introduction

The genus *Ilex* L. is the only living genus in the family of Aquifoliaceae including about 600 species, mainly spreading in North and South America, tropical and temperate Asia and dotted in Europe and Oceania (Manen et al, 2010). It grows in forms of trees, climbers, and shrubs. China is one of the major countries in *Ilex* L. plant resources, of which 200 species distribute largely in southern China, e.g., Guangdong, Yunnan, Hunan, and Zhejiang provinces (Peng et al, 2013).

More than 40 species and their varieties are used for the medicinal purpose, in which *Ilex chinensis* Sims, *I. cornuta* Lindl., *I. rotunda* Thunb., *I. cornuta* Lindl., *I. pernyi* Franch., and *I. pubescens* Hook are botanical resources of crude drugs (Committee of Chinese Herbacology, 2004) in China, and the first three species were recorded in *Chinese Pharmacopoeia 2015* (Pharmacopoeia Committee of P R. China, 2015). They are remedies for clearing heat, moistening the lung, removing phlegm, invigorating the liver and lung in traditional Chinese

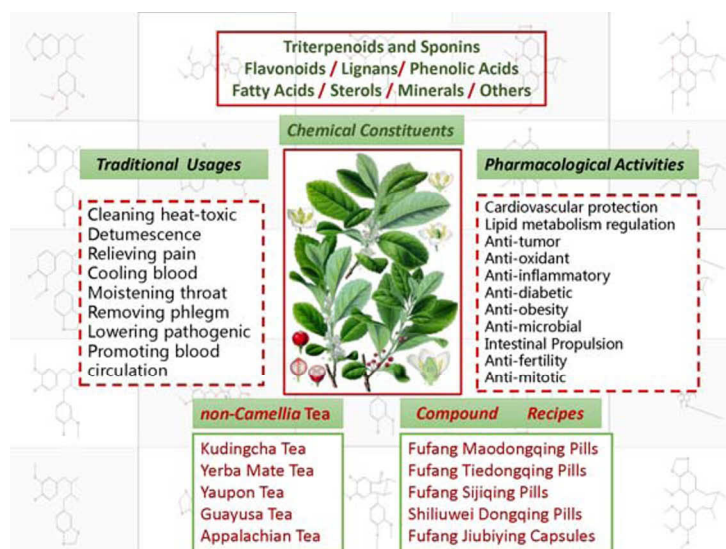
medicine (TCM), and they are also jointly used with other herbs in Chinese patent drugs (Table 1). In addition, several species are used as non-*Camellia* teas due to belong non-*Camellia* species (Han et al, 2013). For example, *I. latifolia* Thunb., *I. kudingcha* C. J. Tseng (Large-leaved Kudingcha), *I. paraguariensis* A. St.-Hil. (Yerba Mate), and *I. vomitoria* Sol. ex Aiton (Yaupon) have being daily drunk to promote human health and prevent cardiovascular diseases in folk of southern China and Western countries especially in North and South of America, e.g. US, Paraguay, Peru, Ecuador, and Brazil for thousands of years.

In the 21st century, there have been great changes in human disease spectrum: increasing people are suffering from modern civilization diseases such as cardiovascular diseases, cancer, and diabetes and excessive increase in medical costs (Samocha et al, 2014). The experiences of traditional therapy show that species in the genus *Ilex* L. are potential remedies for the modern diseases. Here we reviewed the genus *Ilex* L. in phytochemistry, ethnopharmacology, and pharmacology (Figure 1).

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Table 1 Formula containing medicinal species from genus *Ilex* L.

Drugs	Herbs	Efficiency and diseases
Compound Maodongqing and Aluminium Clofibrate Tablets	<i>Ilicis Pubescentis Radix</i> (<i>I. pubescens</i>), vitamin C, vitamin B6, inositol, chlorobenzene butyl aluminum, lecithin	Clearing heat and removing toxicity, activating blood and dredge the meridians. To treat coronary atherosclerosis heart disease
Compound Tiedongqin Pills	<i>Ilicis Rotundae Cortex</i> (<i>I. rotunda</i>), <i>Taraxaci Herba</i> , <i>Paeoniae Rubra Radix</i> , Chinese Honeylocust Spine, <i>Chuanxiong Rhizoma</i> , <i>Carthami Flos</i> , <i>Angelicae Sinensis Radix</i>	Clearing heat and removing toxicity, promoting diuresis and alleviating pain. To treat pelvic inflammatory disease
Compound Sijiqin Pills	<i>Ilicis Chinensis Folium</i> (<i>I. chinensis</i>), <i>Lonicerae Confusae Flos</i>	Clearing heat and removing toxicity, resolving swelling and dissipating blood stasis. To treat cough caused by lung-heat, sore throat, dysentery, hypochondriac pain, heat stranguria; skin ulcer, burns and scalds
Shiliuwei Dongqing Pills	<i>Ilicis Chinensis Folium</i> (<i>I. chinensis</i>), <i>Cinnamomi Cortex</i> , <i>Amomi Rotundus Fructus</i> , <i>Caryophylli Flos</i> , <i>Aucklandiae Radix</i> , <i>Glycyrrhizae Radix</i> , <i>Aquilariae Resinatum Lignum</i> , <i>Bistortae Rhizoma</i> , <i>Piperis Longi Fructus</i> , <i>Myristicae Semen</i> , European Grape Fruit, <i>Carthami Flos</i> , <i>Choerospondiatis Fructus</i>	Clearing heat and removing toxicity, resolving swelling and dissipating blood stasis. To treat edema, cold cough, dizziness
Compound Jiubiyang Capsules	<i>Ilicis Rotundae Cortex</i> (<i>I. rotunda</i>), <i>Atalantiae Buxifoliae Radix</i> , <i>Cyperii Rhizoma</i>	Clearing heat-toxin, inducing diuresis. To treat diarrhea, gastroenteritis

**Figure 1** Chemical components, ethnopharmacology, and pharmacology of plants from *Ilex* L.

2. Phytochemistry of plants in *Ilex* L.

More than 200 compounds have been isolated and identified from the plants of *Ilex* L., including triterpenoids, triterpenoid saponins, flavonoids, sterols, polyphenols, carboxylic acids, and esters. The dominant constituents are triterpenoids and their saponins responsible for the modulation of lipid metabolism activities, anti-obesity, anti-inflammatory, and anti-microbial bioactivities (Table 2). Over the past 30 years, phytochemistry studies have been intensively carried out upon *I. chinensis*, *I. rotunda*, *I. cornuta*, *I. latifolia*, *I. purpurea*, *I. asprella*, and *I. pernyi*.

2.1 Triterpenoids and triterpenoid saponins

A total of 180 triterpenoids and triterpenoid saponins have been isolated and identified from the plants of *Ilex* L. According to chemical diversity of carbocyclics, triterpenoids are classified into acyclic triterpenoid, tricyclic triterpenoid, tetracyclic triterpenoid, and pentacyclic triterpenoid, in which pentacyclic triterpenoids are the dominant that includes lupane pentacyclic triterpenoids, oleanane pentacyclic triterpenoids, and ursane pentacyclic triterpenoids. They are mainly present in the leaves, barks, and root barks of plants in *Ilex* L. instead of other genera.

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