

## Cytotoxic Activity of *Thymus vulgaris*: Antibacterial and Antifungal Activity

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### ABSTRACT

Thymol, an antiseptic, is an active ingredient in various commercially produced mouthwashes such as Listerine. The medicinal properties of wild thyme have been extensively used in official and traditional medicine for many years and centuries, respectively. The herb is used in preparations of natural herbal remedies, such as syrups, tinctures, infusions, decoctions, tea, and oil. The increase in multidrug resistant strains of pathogenic microorganisms has led to extensive phytochemical and pharmacological studies of *T. vulgaris* as an important source of medicinal substances with antioxidant, antimicrobial, antitumor, and cytotoxic properties and their effective medicinal application, as well as use in pharmaceutical, food, and cosmetic industries. According to the PDR for Herbal Medicines, wild thyme is a component in various standardized preparations with antitussive effects, while alcohol extracts are integral components of drops used for coughs and colds.

**Keyword:** *Thymus vulgaris*, Pharmacological Properties, Antioxidant, Antimicrobial, Antitumor, Cytotoxic.

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### INTRODUCTION

Growing to 15–30 cm (6–12 in) tall by 40 cm (16 in) wide, it is a bushy, woody-based evergreen subshrub with small, highly aromatic, grey-green leaves and clusters of purple or pink flowers in early summer<sup>1</sup>. Oil of thyme, the essential oil of common thyme (*Thymus vulgaris*), contains 20–54% thymol. Thyme essential oil also contains a range of additional compounds, such as p-cymene, myrcene, borneol, and linalool. Before the advent of modern antibiotics, oil of thyme was used to medicate bandages. It has also been shown to be effective against various fungi that commonly infect toenails<sup>1-4</sup>. Fresh and dried herbs particularly the upper part of the above ground portion of wild thyme, collected when the plant is in bloom, possess certain healing properties due to the presence of significant amounts of essential oils. The widespread use of different species of the *Thymus* genus dates back to ancient Egypt, where they were used for making perfumed balms, for embalming, and for medical purposes. However, the spread of thyme throughout Europe is thought to be due to the Romans, as they used it to purify their rooms and to “give an aromatic flavour to cheese and liqueurs”. The British Herbal Pharmacopoeia classifies this species as a medicinal plant and among the indications for its use it mentions bronchitis, bronchial catarrh, whooping cough, and sore throats. Whooping cough is singled out as a specific indication. The recommended daily dose of this drug is 4–6 g<sup>5-9</sup>. Numerous compounds in the composition of the essential oil are natural antioxidants that act in metabolic

response to the endogenous production of free radicals and other oxidant species<sup>10-16</sup>. These responses are due to ecological stress or are promoted by toxins produced by pathogenic fungi and bacteria. The biological precursor of carvacrol and another significant component of the plant extracts, p-cymene, has very weak antibacterial properties, but it most likely acts in synergy with carvacrol by expanding the membrane, causing it to become destabilized<sup>17-19</sup>.

#### *Pharmacological Properties*

Many studies on the chemical composition and yields of the essential oils from plants belonging to the *Thymus* genus have been conducted, including those from *T. serpyllum*. The chemical composition and yield of the essential oil of *T. vulgaris* are considered to be affected by geographic region, the development stage of the plant, the harvest season, habitat, and climatic conditions<sup>20-25</sup>. As such, its content varies from 0.1 to 0.6% or even from 0.1 to 1%. Over the last two decades, more and more studies have researched the chemical composition of *T. serpyllum* essential oil. It has been established that plant species of the *Thymus* genus are characterized by chemical polymorphism, meaning that several chemotypes exist (geraniol, germacrene D, citral, linalool, (E)-caryophyllene,  $\alpha$ -terpinyl acetate, carvacrol, and thymol). In addition to essential oil, wild thyme also contains flavonoids, phenol carboxylic acids, and their derivatives, triterpenes and tannins. Besides carvacrol and thymol (Table 1).

#### *Antioxidant Activity*

Table 1: Major pharmacological activity of *Thymus vulgaris*.

Part of plant	System	Effects	Preparation
Capsules	General	Protect against "the evil eye" Djinn treat pain	Dried the capsule and smoke -----
	Biological and pharmaceutical	Skin inflammations Skin cancers emmenagogue and abortifacient agent	
Root	biological	kill lice make inks, stains and tattoos	extract
General		Fertility Antiprotozoal Antibacterial Anticancer hypertension and cardiac disease	
	medical	angiogenic inhibitor platelet aggregation Parkinson's disease anti-depressant effect antimicrobial folk medicine	-----
Seeds		kill insects inhibit the reproduction of the <i>Tribolium castaneum</i> beetle	
	biological	anthelmintic A red dye, "Turkey red" make inks, stains and tattoos Vasorelaxant and antihypertensive	extract extract extract
Stems		make inks, stains and tattoos	extract

The number of published works studying the antioxidant activity of *T. serpyllum* is relatively small, but some have evaluated it and compared it with other species. The oil's chemoprotective efficacy against oxidative stress-mediated disorders is mainly due to its free radical scavenging and metal chelating properties<sup>26-29</sup>. However, the antioxidant activity of the essential oil of *T. serpyllum* is not due to the mere presence of certain dominant components but is the result of the synergism of a larger number of components, including some which are present only in small amounts (trans-nerolidol, germacrene D,  $\delta$ -cadinene, and  $\beta$ -bisabolene).

#### Antimicrobial Activity

Many scientists ascribe the antimicrobial activity of species from the *Thymus* genus to the high concentration of carvacrol in its essential oil. It has biocidal properties, which lead to bacterial membrane perturbations<sup>30-32</sup>. Moreover, it may cross cell membranes, reaching the interior of the cell and interacting with intracellular sites vital for antibacterial activities. Another study showed that wild thyme essential oil has bactericidal effects, but not bacteriostatic effects on the bacterial species *Escherichia coli*, *Salmonella Typhi*, *Shigella ferarie*, *Bacillus megaterium*, *Bacillus subtilis*, *Lactobacillus acidophilus*, *Micrococcus luteus*, *Staphylococcus albus*, *Staphylococcus aureus*, and *Vibrio cholera*. This confirms earlier findings that thymol is a good antimicrobial agent<sup>33-38</sup>.

#### Antitumor and Cytotoxic Activity

As one of the principal constituents of thyme essential oil, carvacrol has important in vitro cytotoxic effects on tumour cells. The 21 compounds isolated, carvacrol, thymol, and thymoquinone are the major components of hexane extract of *Thymus vulgaris* essential oil, and the hexane extract of this species is cytotoxic to 6 cancer cell lines (MDA-MB-231, MCF-7, HepG2, HCT-116, PC3, and A549).

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