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Review Article



Thyme and its inhibitory properties against fungi

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Abstract

The thyme plant is rich in active substances that have an inhibitory effect on microorganisms especially fungi, such as *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *Candida albicans*, *Trichophyton mentagrophytes*.

Keywords: Thyme, fungi, Thymol , Inhibitory effect

Introduction

Thyme (*Thymus vulgaris*) is a woody perennial low-growing. It is a highly aromatic Mediterranean herb that performs especially well in somewhat dry, sunny conditions. The tiny pink, lavender, or white tubular flowers of thyme and are well-liked by bees, plants show up in the summer and spring.

It is found in many and varied regions in the world, such as the plains, mountainous regions, and others. There are many different types of wild thyme in the regions bordering the Mediterranean Sea and a section of Europe, and in the United States of America, France, Germany, and Spain are regions rich in different types of wild thyme, and they are one of the countries that use it most like food or medicine and manufactures its volatile oil and its primary industrial and pharmaceutical compounds and other materials derived from it, as well as in Southeast Asia (Hussain, 1981; Saad Eddin, 1986; Abu Zaid, 1988; Gideon, 2001). The species is widespread in the world, especially in France and Germany, and it is one of the best types and is more widely used than the rest of the other types (Kirby, 2000; Gideon, 2001).

It is also found in northern Iraq, where wild thyme is spread in the northern, northeastern, and western parts of the Iraqi country. It was found in the cantons of Amadiyah, Rawanduz, Sulaymaniyah, and Sinjar Mountain. As for the Dohuk region, it is located on the slopes of Mount Bikhair near Zakho, both Zakho, Dohuk, Zawitah, Sarsang, and Aqrah. In the Sulaymaniyah province, it is found in Tawila, Haiba Sultan, Erbil and Shaqlawa road. As for the district of Mount Sinjar, it is found on the northern and southern slopes, where it was

found in the area of Kersi and Wadi Shiloh between Jadalah and Bara. As for the Rawanduz area, it is found at the foot of Jabal Haj Omran, Qandil, Kali Ali Bey, Shaqlawa and Hendrin (AL-Rawi, 1964; Al-Bayati, 2001).

Thyme spreads on the slopes, mountain tops, hillsides, sides of mountain roads, valleys, rocky crevices, agricultural fields, and oak forests. It grows in clay and sandy gravel soils, and its growth increases in limestone rocks. It also grows in muddy stone lands, gypsum gravel, and limestone gravel, as shown in Fig.1 (Al-Bayati, 2001).



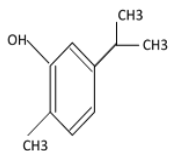
Fig. 1 The thyme plant, its growth, and the nature of its leaves for some of its species

Where it is considered one of the finest types, especially as it contains volatile oils that are important in giving it flavor as food or as food flavors or using it as medicine, especially fumigation, as it sterilizes the respiratory system, mouth, and

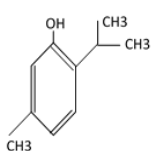
nose, as well as it can be used as a lotion to sterilize membranes and inflamed areas.

Thymus vulgaris or thyme is one of the flowering plants of the family Lamiaceae. Thyme has been used as food and medicine in Europe for a long time, as it has been used to treat diseases of the respiratory system and digestive tract and as an antimicrobial since ancient times (Gideon, 2001; Hamada, 2020).

The leaves, stems, and inflorescences of the thyme plant contain volatile essential oils with an aromatic odor and a sharp taste, 1-2.5% (Roberts et al., 1998) and (25-5 ml/kg) of thyme, which contains phenols, the most important of which are Thymol, Carvacrol, and other compounds. Others such as Linalool, Flavones, Tannins, Caffeic acid, gummy materials, tanning materials, and others. These components are found in proportions that vary from one plant to another according to the type of plant. For example, thyme oil of the type *Thymus vulgaris* L. contains thirteen oils, including Thymol, at a rate of (36-55%), P-cymene (15-28%), r-terpinene (5-10.3%), Carvacrol (2.23-9.83%), Linalool (4-6.2%), α -Terpinene (1.95-2.44%), Myrcene (1.23-1.53%), β -Caryophyllene (1.53-1.55%), Caffeic acid, Tannins, Flavones and its derivatives, tanning materials, gums, and others. These specifications are found in French thyme. And the German one, and it is called Thymol oil due to the presence of the Thymol compound in a large amount in it (Cowan, 1999; Bruneton, 1999; Manou et al., 1998). As for thyme oil, it is of the type *Thymus serpyllum* L. It is also called In Mother of thyme, it contains phenolic compounds ranging between (50-70%), and almost all of them are Carvacrol and Thymol. It is found in very small quantities with other oil compounds. These specifications are found in Spanish thyme oil (Al-Shamaa, 1989). It is worth noting that Thymol and Carvacrol are analogs (isomers) of one compound, which is phenol and its molecular formula is $C_{10}H_{14}O$.



Carvacrol Liquid



Thymol Solid

It's Uses

Thymol and its oil are used as a substance that has preservative properties, as it is used in the preservation of medical and cosmetic preparations, especially those concerned with skin diseases and cracks, as well as in its beauty and spectacles, where Thymol substitutes to increase the skin's resistance to microorganisms and impart an aromatic smell to the medicinal product (Manou et al., 1998) It is also used as an anti-fungal, bacterial and viral, as most of the compounds found in thyme are effective as anti-microorganisms (Carraz and Sarbach, 1964; Panizzi et al., 1993; Woodruff, 1995).

The aqueous extract of thyme leaves and its floral inflorescences is used as an antioxidant drug, and its effectiveness is attributed to Flavones and Biphenyl-type compounds, which are more effective than Butylhydroxytoluene (BHT) as an antioxidant. High oxidation (Bruneton, 1999). Likewise, the phenolic compounds in thyme act as antispasmodics, so they are used as an analgesic for intestinal colic and to treat symptoms of gastroenteritis, stomach and duodenal ulcers, bleeding ulcers, indigestion, and bloating under the stomach area (repels gases) due to the phenols present in its volatile oil. And to the flavones compounds, where it was noted that despite the presence of phenols that prevent contractions that occur in the ileum and trachea in guinea pigs, they are not effective as an antispasmodic except in the presence of flavones compounds, including Polymethoxy flavones and Di-tri-and tetramethoxylated flavones and all of these six compounds Carbon (C-6) (Bruneton, 1999). Thyme steam or its water infusion is used as a syrup to treat cough and whooping cough in people. Children and common cold cases. It is also used as an external ointment and syrup in the treatment of runny nose, nasal congestion, pharyngitis, and an expectorant. It is used for cases of tracheal spasms, bronchitis, and symptoms of upper respiratory infection. It is used for fumigating patients with shortness of breath, especially children in hospitals (Bruneton, 1999; Gideon, 2001). As an anthelmintic, anti-allergic, and nerve tonic after cerebral palsy, as well as used to avoid heart attack, to stimulate the heart, expand the arteries, and remove cholesterol, as well as to treat diarrhea, rheumatism, and sciatica, and prevent hair loss (Bruneton, 1999; Benito et al., 1996; Hussein, 1981; Al-Abaji and Thanoun, 1993; Al-Bitar, 1998).

The effect of thyme on fungi

The presence of Thymol and Carvacrol compounds which are considered antifungals (Al-Shammaa, 1989; Gideon, 2001), where Carvacrol extracted from thyme inhibited the growth of *Aspergillus flavus* and *A. parasiticus* and their production of Aflatoxin B1 and G1 toxins in vitro at a concentration of 100 ppm (Roberts et al., 1998). Thymol and oils extracted from thyme are rich in phenols and have great fungicidal efficacy as they inhibit the growth of molds in medical and cosmetic preparations (Bruneton, 1999), and the aqueous extract of thyme plant at a concentration of 30 mg/ml of the culture medium inhibited the growth of *A. flavus*, and the alcoholic extract of thyme inhibited the growth of fungi at a concentration of 5 mg/ml from the culture medium. In addition, thyme oil also inhibited the growth of the fungus when diluted with 1/200 ml of sterile distilled water. The aqueous extract of thyme also inhibited the production of aflatoxin B1 toxins (Mohammed, 1999; Daferera et al., 2000)

as well as the extract. The aqueous extract of thyme and aqueous extract of thyme inhibited the growth of the fungus *Geotrichum candidum* by 88.5% at a concentration of 25 mg/ml, while the alcoholic extract inhibited the growth of the fungus by 98.7% and 97.5% at a concentration of 7.5 mg/ml and 5 mg/ml, respectively (Al-Amri, 2004; Nickavar et al., 2005) also mentioned that thyme volatile oil has many benefits as antimicrobial, antiviral (Ocana and Reglero, 2012; Khafaji, 2018), anti-oxidant and anti-convulsive, as well as being beneficial for the respiratory system. AlMagtari et al. (2011) also found that thyme is Anti-fungals such as *Candida* and *Aspergillus niger*, where thyme is used as a preservative to preserve food from spoilage and contamination with fungi and their toxins. (Dorman and Deans, 2000; Asensio et al., 2008). A study was conducted in a doctoral thesis (Al-Rejaboo, 2004) on the inhibitory effect of the aqueous and alcoholic extract. I also extracted the thymol compound from the thyme plant and conducted a diagnostic study on it and tested its inhibitory effect against the fungi *Aspergillus flavus*, *A. fumigatus*, *A. niger*, and *Candida spp.*, and *Trichophyton mentagrophytes*.

Where a clear inhibition was observed towards all the fungi under study, especially the alcoholic extract and thymol extract and from the Minimum inhibition concentration (MIC) of the alcoholic extract towards *A. fumigatus* (Picture 2) The percentage of inhibition was 100% at 2 mg/ml, and 90.4% at the concentration 1.5 mg/ml, while the inhibition of thymol was 100% at the concentration of 1.5 mg/ml.

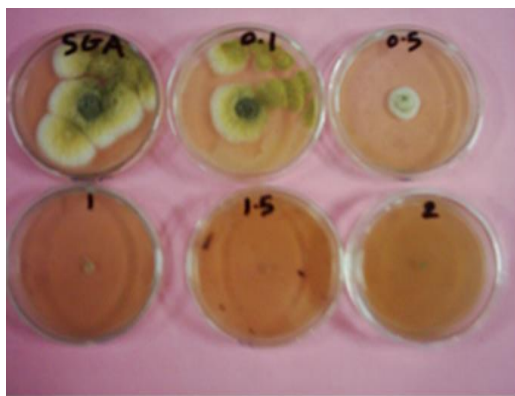


Fig. 2 The inhibitory effect of alcoholic extract of thyme on *Aspergillus fumigatus*

While the alcoholic extract and thymol compound extracted from thyme plant completely 100% inhibited the growth of *Aspergillus niger* at a concentration of 1.5 mg/ml Fig.3

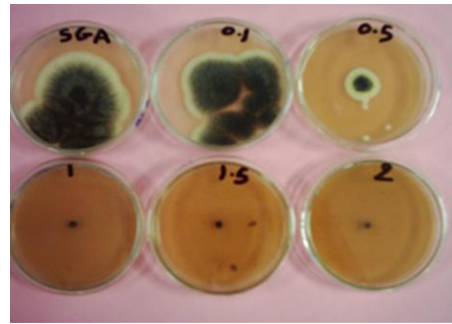


Fig. 3 Inhibitory effect of alcoholic extract of thyme against *Aspergillus niger* isolated from ear swabs (CSOM).

Also, the alcoholic extract and thymol of the thyme plant inhibited the growth of *Candida albicans* As shown in Fig.4

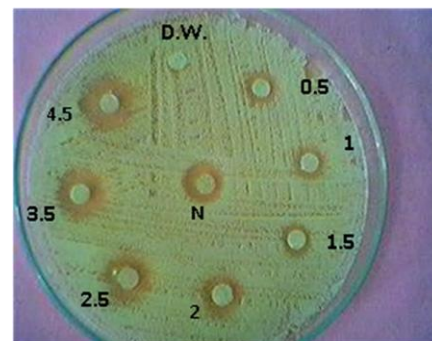


Fig. 4 The inhibitory effect of the alcoholic extract of thyme, Thymol, and the antifungal Nystatin on *Candida albicans* isolated from vaginal swabs (VS)

Also, the alcoholic extract and thymol compound inhibited the growth of the fungus *Trichophyton mentagrophytes* 100% at a concentration of 0.5 mg/ml as shown in the Fig. 5

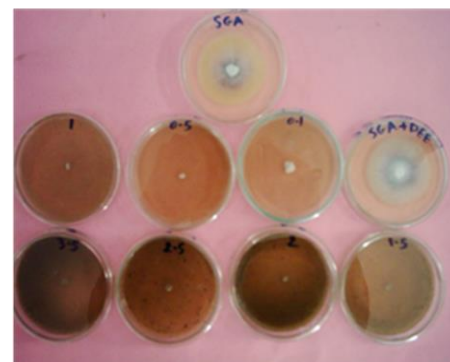


Fig. 5 Inhibitory effects of alcoholic extract and Thymol compound extracted from the sage plant on *Trichophyton mentagrophytes*

The alcoholic extract of thyme plant inhibited *Aspergillus flavus* 100% at a concentration of 3.5 g/ml, while thymol extract inhibited the growth of the fungus 100% at a concentration of 1 mg/ml as shown in Fig. 6.

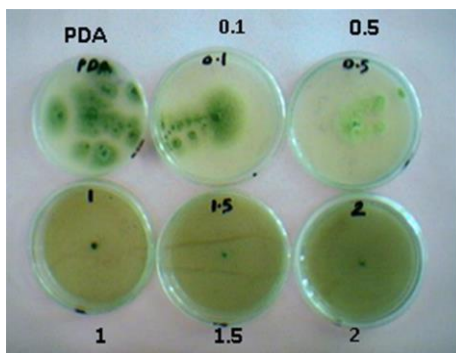


Fig. 6 Inhibitory effect of alcoholic extract of thyme against *Aspergillus flavus* isolated from maize seeds.

Thus, we note that most of the fungi under study were 100% inhibited when treated with alcoholic extract of thyme plant, as shown in Fig.7 (Al-Rejaboo, 2004).

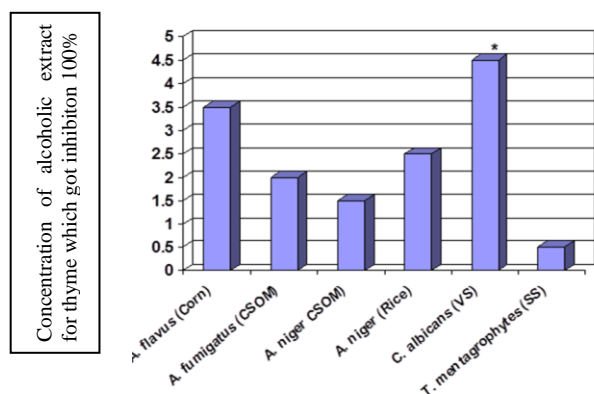


Fig. 7 Concentrations of alcoholic extract of thyme, which gave an inhibition rate of 100%, according to the type of fungi.

In the study of Al-Rejaboo (2019) the effect of thymol extracted from thyme was tested as an inhibitor of the growth of the fungus *Fusarium graminearum* which caused grape damage and *Penicillium nalgiovense* which caused grapefruit and orange damage. Thymol 100% inhibited the growth of *F. graminearum* at a concentration of 0.5 mg/ml and *P. nalgiovense* at a concentration of 1.5 mg/ml. Also, a joint study was conducted on the mutagenic effect of the thymol compound on the conidia of the fungus *Aspergillus amstelodami*. It was found that the concentration of 30 and 25 $\mu\text{g} / \text{ml}$ showed a clear and high-frequency mutagenic effect towards the fungi conidia, while the low concentrations of it 1, 10, and 20 $\mu\text{g} / \text{ml}$ did not show a mutagenic effect on the fungi. It is recommended to use the thymol compound to preserve fruits, vegetables, and vegetable crops whose outer shell is removed to prevent damage during shipping, storage,

and export, or the use of low concentrations of it as preservatives (Al-Rawi and Al-Rejaboo, 2010).

Conflict of Interest

The author hereby declares no conflict of interest.

Consent for publication

The author declares that the work has consent for publication.

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