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REVIEW PAPER

Evaluation of antimicrobial activity of essential oil of *Pistacia khinjuk* in Iran

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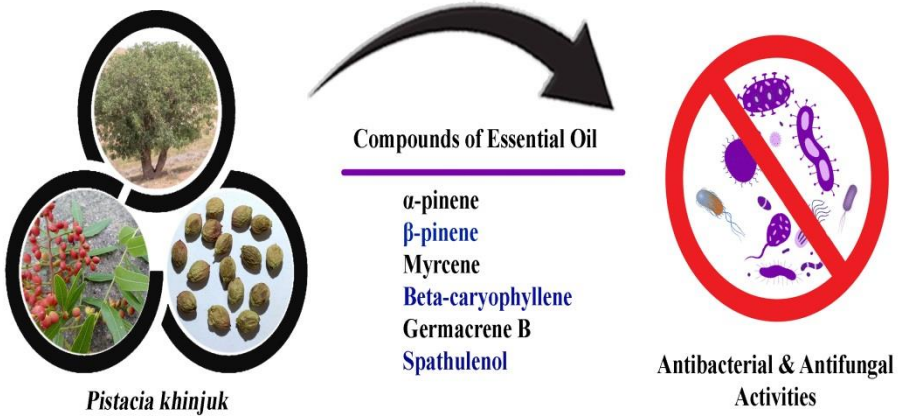
Highlights

- The species of *Pistacia khinjuk* habitat is in most parts of Iran, especially the Zagros region.
- The composition of essential oil of *Pistacia khinjuk* is important.
- Due to antimicrobial effects and food preservative of various species of this plant.
- The extracts showed antimicrobial activity against bacteria and fungi.

Graphical Abstract



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Abstract

Today, with increasing prevalence antibiotic resistance monitoring the health and quality of food has become complicated and difficult. Therefore, essential oils of medicinal plants is significant and the investigation on the composition of essential oil of *Pistacia khinjuk* is important. Due to antimicrobial effects and food preservative of various species of this plant. In this study aim was to Survey the antimicrobial activity of the essential oil of *Pistacia khinjuk* in Iran. This study data collection by articles in internal databases such as, Irandoc, SID and external databases including Science Direct, Scopus, PubMed, Elsevier, Google Scholar. The comparison of the analysis of the essential oil of this plant related to the geographical diversity in Iran.The major compounds of essential oil from the P. khinjuk are α-pinene, β-pinene, Myrcene, beta-caryophyllene, Germacrene B and Spathulenol. The extracts showed antimicrobial activity against bacteria and fungi. The essential oil of the different leaves extracts of *P.khinjuk* (chloroform, ethyl acetate, ethyl alcohol, diethyl ether) like other species of *Pistacia khinjuk* show antibacterial and antifungal activities.

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Introduction

Food pollution is a global challenge. With the increasing population, food processing and distribution that have become more difficult and complex, raising consumer concerns have been associated with health, safety and food quality monitoring, especially in developing countries discovered that access to healthy food is very low (1). *Pistacia khinjuk* one of the Anacardias family, It is a species of wild pistachio in Iran that has Motika cultivars its spread from Canary Islands Kabulika, the countries of the Mediterranean coast start and end up in Asian Minor, Syria, Caucasus, Iran, Afghanistan and Pakistan finds (2). The species of *Pistacia khinjuk* habitat is in most parts of Iran, especially the Zagros region (3). and Kurdistan as used traditional medicine that to relieve abdominal pain, stomach pain, indigestion and stomach ulcers,asthma, eczema, throat infections, kidney stones, anti-diarrhea and fever are considered antibacterial (4). This kind of seamstress middle and southern have more abundance and to the extent the distance between the cold and subtropical regions of the country (5).

The outer shell is green, 24% is *khinjuk* fruit and it has about 30% oil. Studies show that the outer shell oil of coriander has a very high oxidative stability (6). One of the factors affective the distribution and establishment of these species conditions physiography including slope, direction and height (7). The very high on antioxidant effect of *khinjuk* fruit has been confirmed by researchers (8). Hatamnia et al., 2014, Performed studies on the antioxidant activity and phenol content of all different parts of the fruit of 5 *khinjuk* genotypes (9). Due to its low cost and practical features, it seems necessary to solve the problem fat oxidation and microbial growth in this product of antioxidants natural and cheap. This study aimed that to used *Pistacia khinjuk* essential oils polyphenol as an alternative antimicrobial agent it was studied in Iran.

Results

In this study, the antibacterial activity of extract of the leaves and derm fruits of *P. khinjuk*having antibiotics. So, the comparison of the analysis of the essential oil of this plant related to the geographical diversity in Iran. The major compounds of essential oil from the *P. khinjuk* are α-pinene, β-pinene, Myrcene, Bcaryophyllene, Germacrene B and Spathulenol. The extracts showed antimicrobial activity against bacteria (MIC=0.02-0.5 mg/ml) and fungi (MIC=0.06-0.4 mg/ml). The essential oil of the different leaves extracts of *P. khinjuk* (chloroform, ethyl acetate, ethyl alcohol, diethyl ether) like other species of *Pistacia* show antibacterial and antifungal activities (4). Hanafi et al., 2012, Results of the minimum inhibitory concentration (MIC) for *Clostridium Sporogenes, Escherichia coli,* and *Staphylococcus aureus,* respectively 0.6, 0.5, and 0.8 ml/mg, also the results of lethal concentration (MBC) for *Clostridium sporogenesis, Escherichia coli, and Staphylococcus aureus* was determined to be 120, 80, and 20 mg/ml respectively. The research shows that pinene-α is a compound antimicrobial is very important in the essential oil of the leaves of the species *Pistacia khinjuk* (10).

The antioxidant activity of the produced films was also evaluated by free radical scavenging test the results GC test showed that Alpha pinene (77.1%) is the major constituent of essential oil. the results showed that films containing *khinjuk* essential oil have desirable antimicrobial and antioxidant activity, which with increasing the amount of essential oil, these properties in the films increased, and the FTIR-ATR spectrum confirmed the essential oil content of the film. According to the findings of this study *khinjuk* essential oil can be used as a natural preservative in biodegradable films, The effect of *khinjuk* essential oil on antimicrobial and antioxidant properties the food movie (11). Evaluation of the antimicrobial effect of essential oil on *Salmonella typhimurium* in chicken meat was investigated as follows. Therefore, the test was repeated with percentages of 0.25, 0.5, 0.75, 1, and 1.5. The results showed that the minimum inhibitory concentration (MIC) of essential oil was 1% (12). The counting of bacteria in *khinjuk* of Iranian Institute of Standards and Industrial Research (13).

Mahmoudvand et al., 2015, in a study on the possibility of producing a starch film containing essential oil of *khinjuk* was examined (11). The results of the test are determined antioxidant activity showed that these films have activity antioxidant especially in concentrations high essential oil has a significant effect on inhibiting the growth of a wide range pathogenic microorganisms. Spectrum FTIR-ATR from film containing essential oil also indicates chemical interactions between essential oil compounds and functional groups the polymer network

was starch. Finally, it is suggested which can be found in active starchy films containing coriander essential oil, As an antioxidant and antimicrobial packaging products with low moisture and high fat such as fat cakes used (11). With increasing the amount of essential oil, the content of phenolic compounds significantly increased the trend of the results of this study in previous studies on films a composition of containing different essential oils has also been observed (14, 15). Mahmoudvand et al., 2015, demonstrated that with increasing essential oil concentration, antimicrobial activity of films significantly increased and at the level of 2% the most antimicrobial effect videos were viewed. It is clear that the greater the value of the essential oil is in contact with a constant population of microbes, resistance (11).

Sallam et al., 2004, investigated the antioxidant and antimicrobial effects of garlic and anthrax in sausage. They prepared equal concentrations of fresh garlic, garlic powder and garlic essential oil and added it to chicken, that the results show that fresh route has more inhibitory effects on oxidation and microbial growth (16). Taran et al., 2010, investigated the antimicrobial effect of 30 grams per 120 ml of Kelhong leaf powder on *Bacillus subtilis*, *Enterococcus Faecium*, *Staphylococcus aureus*, *Staphylococcus epidermis*, *Escherichia coli*, *Klebsiella pneumonia,* and *Candida albicans.* They showed that this plant has antibacterial and antifungal effects (17). Hecer et al., 2011, examined the microbiological properties of mechanically ossified chicken meat (MDCM) in which lactic acid, acetic acid, and sodium lactate were used, and the results showed that the prepared solution had a shelf life of one increased the day and also has a good effect on the taste of meat (18).

Mohamed and Mansour, 2012 showed that by adding a combination of major essential oils in the beef paste with mechanically ossified chicken (MDCM), adding natural antioxidants could increase fat stability, as well as flavor and aroma improve meat (19). Sampaio et al., 2012, studied the effect of natural antioxidant compounds on the fat oxidation of refrigerated chicken. They found oregano and honey in cooked chicken; acceptable results could be obtained in inhibiting fat oxidation during refrigeration (20). Farhoosh et al., 2009, in this research, in order to gain access to new sources of edible oils, kernel oil and some of its physicochemical properties are investigated (8). The first, the percentage of *khinjuk* fat was determined by the solvent extraction method, which is 3%. Then the chemical indices of iodine number 70.98 peroxide, 0.06 soap, 03.172, and acidic number 0.52 and refractive index in khanjuk kernel oil were investigated. Finally, the type of fatty acids in the oil was determined by GC and it was found that the amount of oleic acid (39.57%) and linoleic acid is 50.23% more than other fatty acids. The significant percentage of essential fatty acids in the *khinjuk* brain and their high nutritional value are important (21, 22).

Abbassi et al., 2018, potential of coriander tree by products in Kurdistan province, the first conference on new topics in agriculture, Islamic Azad University, Saveh branch. The results showed that different diameter classes affected traits such as the amount of sap (turpentine), fruit amount, tree height and freshness and were statistically significant at the level of one percent. Among the different diameter classes, the highest and lowest amount of milk with averages of 351.16 and 197.86 g were related to the diameter classes of 41-50 and 20-30 cm, respectively, and this difference was about 43.65% (21). The results show the use of subcritical water as a suitable method of direction extraction of biological materials from coriander skin with advantages such as high extraction efficiency, abundant solvents, cheap and Proves without any negative environmental effects (6). Hatamnia et al., 2014, Nutrients, bioactive compounds and antioxidant activities of walnut male inflorescences at four flowering stages were analyzed in this study. The results showed that the male inflorescences were rich in carbohydrate, protein and mineral contents, and had antioxidant activities (9).

Discussion

It was also found that the effect of essential oils on gram positive bacteria is more than gram negative. In some cases, essential oils had an inhibitory effect on beneficial bacteria such as lactobacilli (23). Ntzimani et al., 2010, The present study examined the effect of natural antimicrobials: Ethylene diamine tetraacetate (EDTA), lysozyme, rosemary and oregano oil and their combinations, on the shelf-life of cooked coated chicken fillets stored under vacuum packaging (VP), at 4 ± 0.5 °C for 18 days (23). The treatments of cooked coated chicken

fillets examined in the present study were the following: Air-packaged (A, control samples), vacuum-packaged (VP), VP with EDTA–lysozyme solution 1.50% w/w (24).

In some studies based on antimicrobial activity essential oils and various extracts and other components types of coriander plant species in addition to high susceptibility to gram negative is directly related to increased antimicrobial activity in the concentration of essential oil antimicrobial activity can be attributed to compounds including linalool and alpha terpineol (25). Also, studies were performed to determine the antioxidant and antimicrobial activity of some coriander species (17, 26, 27). The results are in accordance with Mahmoudvand et al., study various researches also show (11). The fact is that the species, the place of growth and the geographical climate in which the plant grows affect the type and amount of its chemical composition (28). That with increasing essential oil concentration, antimicrobial activity of films significantly Increased and at the level of 2% the most antimicrobial were observed the greater the value of the essential oil is in contact with a resistant population of microbes, such a result in other research has been done on films containing essential oils has been observed (29). Films containing coriander essential oil had a greater antimicrobial effect on positive bacteria than negative (24). Some studies on antimicrobial activity essential oils and various extracts from gum and other components. Types of coriander plant species in addition to high susceptibility to bacteria negative is directly related to increased antimicrobial activity an increase in the concentration of essential oil or extract has been reported (20, 30). Antimicrobial activity in this essential oil can be attributed to compounds such as linalool and terpineol (31, 32). The most sensitive gram negative bacteria are *Shigella flexneri* and *Salmonella typhi*. It was the most resistant bacterium that can be resisted multiple combination systems responsible for changing the environment is foreign, attributed. Among the fungi tested *Candida albicans* is sensitive and *Aspergillus* is resistant fungus that been reported (33-35).

Conclusion

However, the antimicrobial effect with an increase in extract concentration intensified but overall this effect was evaluated as moderate antimicrobial effect can be due to insufficient active ingredients of the plant fruit. As a result, Investigation of antimicrobial effect of plant extracts and study of antimicrobial effect of other plant organs may have better antimicrobial results shown. Antimicrobial susceptibility due to different structures of microorganisms is different concentrations of the extract that the anti-microbial effect is verified in several studies. The culture medium used in the tests antimicrobial effects also have a great effect on the antimicrobial properties it has extracts. The use of different organs of the plant is also having antimicrobial effect of the extract is effective.

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