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REVIEW: *Astrodaucus persicus* (Boiss.) Drude: A Mini-Review on Phytochemistry and Pharmacological Effects

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ABSTRACT

Astrodaucus persicus (Boiss) Drude is an annual flowering plant of the Apiaceae family. *A. persicus* is mainly native to Asia and grows mostly in Iran, Turkey, Syria, and Iraq. In Iran, it grows mainly in Mazandaran, Golestan, Semnan, Tehran, Qazvin, and Kurdistan provinces. In Iran and Turkey, the plant's aerial parts and young roots are traditionally used as food additives. Various studies have been performed on essential oils and plant extracts. Essential oil compounds and some plant extract compounds have been identified. Different pharmacological effects of plant extracts and essential oils have also been reported. Monoterpenes are the main constituents in the essential oils of various parts of *A. persicus*. Plant extract (especially plant roots extract) effectively treats breast and colorectal cancers, which seems to be due to the presence of benzodioxole compounds or the antioxidant effects in the roots. The ripe fruits of the plant have potent larvicidal effects. Also, the fruits and roots of the plant significantly inhibit Plasmodium berghei, which can be effective in treating malaria.

Introduction

Astrodaucus persicus (Boiss) Drude is an annual flowering plant of the Apiaceae family. The stems of the plant are straight and branched, and the flowers are white and egg-shaped. The plant's height can reach 40-120 cm depending on the region (1, 2). *A. persicus* is mainly native to Asia and grows mostly in Iran, Turkey, Syria, and Iraq. In Iran (3), it grows mainly in Mazandaran, Golestan, Semnan, Tehran, Qazvin, and Kurdistan provinces (4). In Iran and Turkey, the plant's aerial parts and young roots are traditionally used as food additives (3). In this study, phytochemical and pharmacological effects of *A. persicus* were reviewed.

Phytochemistry

According to studies, the essential oil of *A. persicus* is mainly composed of monoterpenes and sesquiterpenes. Major essential oil compounds are presented in ***Figure 1***. Also, five main compounds have

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been isolated and identified from the methanolic extract of the plant, which is shown in ***Figure 2***.

A. persicus aerial parts was collected in the flowering stage in July 2000 from the northeastern areas of Tehran by M. Bigdeli *et al*. 180 g of aerial parts were hydrodistillated for 3 hours in Clevenger to prepare essential oil (yellow). 41 compounds of yellow essential oil of the plant were identified. Decanal (34.8%), dodecanal (15.5%), dodecanol (14.3%), decanol (9.3%) and carvacrol (8.6%) were the main compounds in the essential oil (5).

A. persicus seeds were collected in October 2001 from the northern regions of Iran. To prepare the essential oil (pale yellow), 90 g of dried and finely ground seeds were exposed to hydrodistillation for 4 hours in Clevenger. 99.7% of essential oil compounds were identified in the form of 18 compounds. Geranyl acetate (39.0%), alpha-pinene (13.2%), sabinene (12.9%), (E) -methyl isoeugenol (7.9%) and myrcene (7.2%) were the main compounds in the plant (2).

In July 2004, Y. T. Bazargani *et al*. collected the roots and aerial parts of *A. persicus* from Taleghan (Qazvin Province, Iran). 400 g of roots, 1700 g of stems and leaves and 350 g of flowers and fruits of the plant were exposed to hydrodistillation for 4 hours in Clevenger. 94.4% of the yellow essential oil of the roots (22 compounds), 99.7% of the green essential oil of the stems and leaves (20 compounds) and 99.9% of the bluish-green essential oil of the flowers and fruits (14 compounds) were identified. Bornyl acetate (26.5%), beta-sesquiphellandrene (25.9%) and exo-fenchyl acetate (25.1%) were the main root compounds, alpha-pinene (56.4%) and exo-fenchyl acetate (37.7%) were the main stem and leave compounds and Beta-pinene (46.1%), alpha-pinene (26.1%) and alpha-thujene (14.4%) were the main compounds of flowers and fruits. The essential oils of roots, stems and leaves, flowers and fruits contained 63.7%, 98.8% and 99.7% of monoterpenes and 30.7%, 0.9% and 0.2% of sesquiterpenes, respectively (6).

Goodarzi *et al*. (2016) collected flowers/fruits, leaves/stems in June 2010 and ripe fruits and roots of *A. persicus* in September 2010 from Irankhah village (Kurdistan Province, Iran). For the preparation of the essential oil, plant components were subjected to hydrodistillation in Clevenger for 4 hours. 98.5% (21 compounds), 98.6% (15 compounds), 98.9% (24 compounds), and 100% (21 compounds) of the compounds present in flowers/fruits, leaves/stems, ripe fruits, and plant roots essential oils were identified, respectively. Alpha-thujene (43.8%), alpha-pinene (20.9%), and beta-pinene (21.3%) were the main compounds of flowers/fruits. Alpha-thujene (48.0%), alpha-pinene (27.7%), and alpha-fenchene (9.2%) were the main compounds of the stem/leaves. Alpha-thujene (17.6%), alpha-pinene (14.3%), and beta-pinene (56.9%) were the main compounds of ripe fruits, and trans-Caryophyllene (33.5%), Bicyclogermacrene (27.3%), Germacrene-D (11.6%), And beta-farnesene (7.2%) were the main compounds of roots. The essential oils of flowers/fruits, stems/leaves, ripe fruits and roots contained 97.3%, 96.5%, 95.9% and 5.2% of monoterpenes and 1.4%, 2.1%, 1.1% and 90.7% of sesquiterpenes, respectively (7).

A. persicus roots that collected in September 2012 from Irankhah village (Kurdistan Province, Iran) were evaluated by S. Goodarzi *et al*. Methanolic extract of the roots was fractionated by hexane, chloroform, ethyl acetate, and methanol. Finally, the following compounds were isolated and identified (3):

- 5 - ((propanoyl methyl) amino) -4,7-dimethoxybenzo [d] [1,3] dioxole
- 5- (3-ethyloxiran-2-yloxy) -4,7-dimethoxybenzo [d] [1,3] dioxole
- 4,7-dimethoxy-5- (propanonyl) benzo [d] [1,3] dioxole
- 4-ethoxybenzo [d] [1,3] dioxol-6-carbaldehyde
- 4- (O-β-D-glucopyranosyl) -6- (3-propanyloxiran-2-yloxy) benzo [d] [1,3] dioxole (8)

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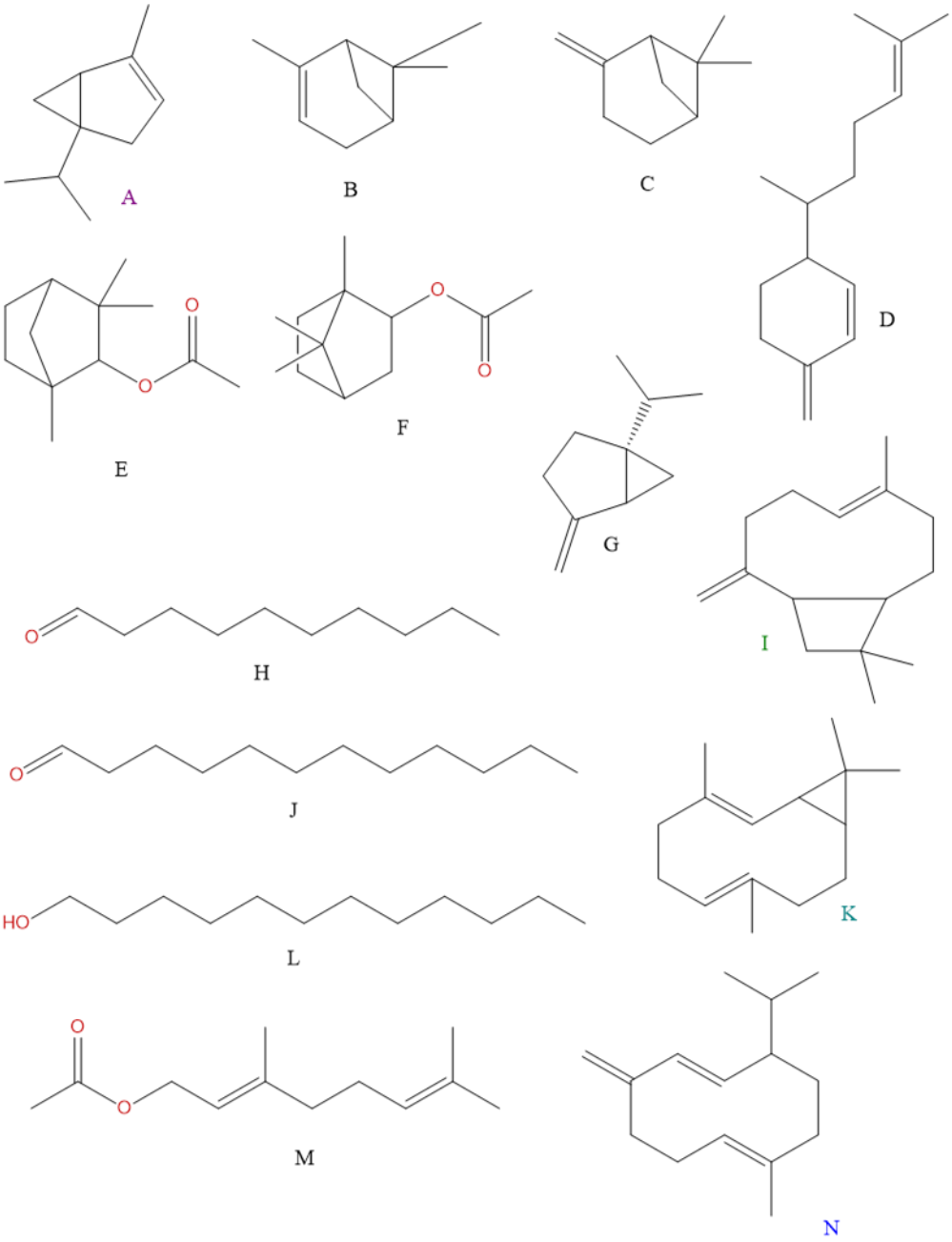

Figure 1. Major essential oil compounds. A: alpha-Thujene, B: alpha-Pinene, C: beta-Pinene, D: beta-Sesquiphellandrene, E: Exo-Fenchyl acetate, F: Bornyl acetate, G: Sabinene, H: Decanal, I: trans-Caryophyllene, J: Dodecanal, K: Bicyclogermacrene, L: Dodecanol, M: Geranyl acetate, N: Germacrene D.

Pharmacological activities

Antioxidant

Aerial parts and roots of *A. persicus* were extracted by the Soxhlet method with methanol. The extracts showed potent anti-proliferative effects on T47D cell lines compared to RPMI control and doxorubicin. The extract of the root had stronger anticancer effects than the extract of aerial parts. IC_{50} of the extract of the aerial part and the extract of roots were reported to be 1 mg/mL and 0.5 mg/mL, respectively. Both extracts were treated on G1 phases of the cell cycle of T47D cells, but doxorubicin was treated on G2/M phases of the cell cycle of T47D cells. The pattern of cell cycle phase distribution of both extracts was similar to RPMI control, but it differs from doxorubicin (9).

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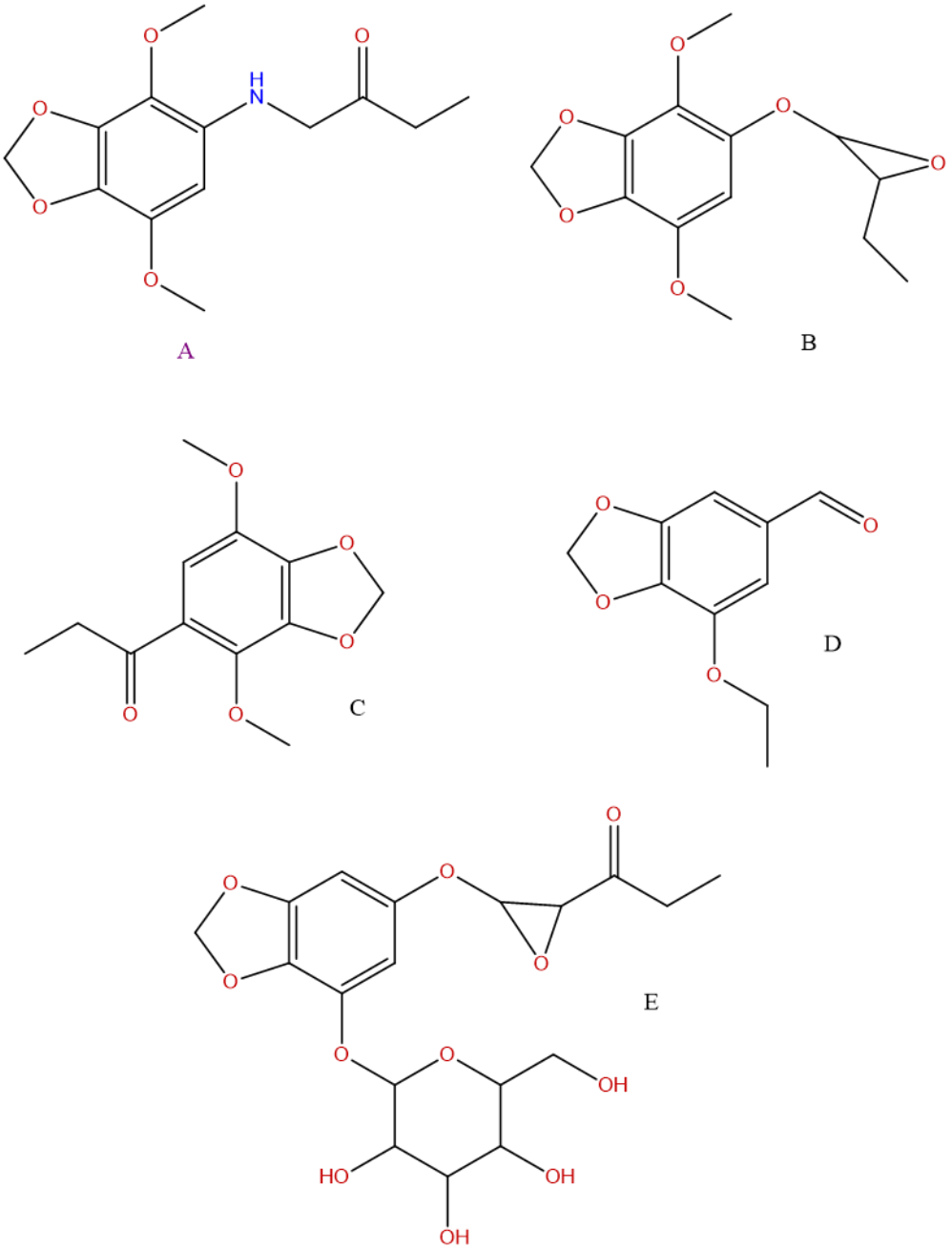

Figure 2. Major compounds isolated from methanolic extract. A: 5-((propanoyl methyl)amino)-4,7-dimethoxybenzo[d][1,3]dioxole, B: 5-(3-ethyloxiran-2-yloxy)-4,7-dimethoxybenzo[d][1,3]dioxole, C: 4,7-dimethoxy-5-(propanonyl) benzo[d][1,3]dioxole, D: 4-ethoxybenzo[d][1,3]dioxol-6-carbaldehyde, E: 4-(O-β-D-glucopyranosyl)-6-(3-propanyloxiran-2-yloxy)benzo[d][1,3]dioxole.

Hexane fraction of root of *A. persicus* extract showed potent anticancer activity against MCF-7 breast adenocarcinoma (IC_{50} of 0.01±0.01 µg/mL), SW480 colorectal carcinoma (IC_{50} of 0.36±0.1 µg/mL) and L929 normal cell lines (IC_{50} of 0.70±0.12 µg/mL) in comparison to doxorubicin with IC_{50} of 0.35±0.07, 2.50±0.80 and 0.55±0.06 µg/mL respectively. Also, the chloroform fraction of fruit extract showed strong cytotoxicity on SW480 colorectal carcinoma cell lines (IC_{50} of 5.42±1.24 µg/mL). This statement is remarkable that IC_{50} less than 20 µg/mL for crude extracts and less than 4 µg/mL for pure compounds indicated activity against cancer cell lines (10).

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Aerial parts and roots of *A. persicus* extracted with methanol by the soxhlet method. In the IC50 concentration, methanolic extracts of aerial parts and roots increased p53 expression, methanolic extract of aerial parts increased Bcl-2 expression, and methanolic extract of roots decreased Bcl-2 expression in T47D cells in comparison to RPMI significantly ($p<0.05$). The aerial parts and root extracts decreased the nuclear staining of p53 and cytoplasmic staining of Bcl-2 proteins in T47D cells' treatment compared to RPMI control. Anti-proliferative activity of *A. persicus* on T47D breast carcinoma cells may be related to the presence of coumarin compounds in this plant (4).

Antimalaria

Fruits and roots of *A. persicus* were extracted with 80% methanol with the maceration method. At 160 g/L, chloroform and ethyl acetate fractions of fruits extract had the best larvicidal effect after 24h treatment with the rate of 98% (LC_{50} of 45.11g/L and LC_{90} of 139.36 g/L) and 97% (LC_{50} of 34.49 g/L and LC_{90} of 108.61 g/L), respectively. The larvicidal effect of ethyl acetate fraction of fruits was better than chloroform fraction at lower concentrations. Also, petroleum ether fraction of roots and fruits showed 80% (LC_{50} of 101.21 g/L and LC_{90} of 478.94 g/L) and 74% (LC_{50} of 82.53 g/L and LC_{90} of 513.60 g/L) mortality rates at 160g/L, respectively. Generally, different fractions of fruit extract had stronger insecticidal effects (11).

Goodarzi *et al.* (2017) were extracted the ripe fruits and roots of *A. persicus* with 80% methanol. Fruits and roots extract fractionated with chloroform, ethyl acetate, hexane, and methanol. At 500 mg/kg/day, hexane fraction of roots (73% suppression, P=0.023) and ethyl acetate fraction of fruits (72.3% suppression, P=0.045) was the most effective fractions in inhibiting *Plasmodium berghei* on the fourth day. The other fractions did not show a significant effect (10).

Conclusion

Monoterpenes are the main constituents in the essential oils of various parts of *A. persicus*. Plant extract (especially plant roots extract) effectively treats breast and colorectal cancers, which seems to be due to the presence of benzodioxole compounds or the antioxidant effects in the roots. The ripe fruits of the plant have potent larvicidal effects. Also, the fruits and roots of the plant significantly inhibit *Plasmodium berghei*, which can be effective in treating malaria. Based on this fact that *A. persicus* has potential effects in the treatment of various diseases. It seems that more research is needed on this plant.

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Conflicts of interest

The authors declare no conflict of interest in this study.

Authors' contributions

All authors have intellectually contributed to the study design and process. In detail, M.H.H searched databases and evaluated relevant articles for inclusion in the study; F.B and M.H.H wrote and revised the first draft of the manuscript; M.A.E supervised the team and evaluated the scientific accuracy of the content. The final manuscript was revised and approved by all authors.

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