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A Narrative Review on the Cardiovascular Pharmacology of *Ocimum basilicum* L.

Abstract

Cardiovascular diseases (CVDs), primarily ischemic heart disease and stroke, remain the leading global cause of mortality and disability. This growing burden highlights the urgent need for effective and safe preventive strategies. Herbal medicines are increasingly being explored as cost-effective alternatives, and *Ocimum basilicum* Linn. commonly known as sweet basil; *Tulsī*; and "*Rayhān*" in Unani medicine, has drawn attention for its cardioprotective potential. Phytochemical studies reveal that sweet basil contains terpenoids, phenylpropanoids, flavonoids, and phenolic compounds such as rosmarinic acid, with key constituents including linalool, eugenol, estragole, geraniol, and camphor. Traditionally, it has been recognized in the Unani medicine as one of the 50 cardioactive plants, valued for its aromatic, astringent, and exhilarating actions, and used in conditions such as palpitations, anxiety, and headaches. Modern pharmacological investigations corroborate these traditional claims, demonstrating antihypertensive, anti-arrhythmic, antioxidant, vasorelaxant, anti-thrombotic, and anti-platelet effects. This review integrates traditional Unani knowledge with contemporary evidence, underscoring potential of sweet basil as a natural cardioprotective agent and advocating for further studies to establish its role in cardiovascular disease management.

Keywords: Cardiovascular diseases; flavonoids; *Ocimum basilicum* Linn; Sweet Basil; Unani Medicine

Toyiba Ibrahim[1*]
Mohd Afsahul Kalam[2]
Sana Bila Suhail[3]

[1] PG Scholar, Department of Ilmul Advia (Pharmacology), Regional Research Institute of Unani Medicine, Srinagar, 190006, J&K
[2] Professor and Head of the Department, Department of Ilmul Advia (Pharmacology), Regional Research Institute ofUnani Medicine, 190006, J&K
[3] PG Scholar, Department of Moalajāt (Medicine), Regional Research Institute of Unani Medicine, 190006,J&K

CORRESPONDING AUTHOR

Toyiba Ibrahim
Email: toyiba.dr@gmail.com

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Introduction:

Cardiovascular diseases (CVDs) remain the leading cause of disease burden in the world. CVDs burden continues its decades-long rise for almost all countries outside high-income countries, and alarmingly, the age-standardized rate of CVDs has begun to rise in some locations where it was previously declining in high-income countries. Cardiovascular diseases, mainly ischemic heart disease (IHD) and stroke, remain the leading global cause of death and disability. According to the Global Burden of Disease Study data, total CVDs cases almost doubled from 271 million in 1990 to 523 million in 2019, with deaths rising from 12.1 to 18.6 million. In 2019, IHD accounted for 197 million cases and 9.14 million deaths, while stroke contributed 101 million cases and 6.55 million deaths, highlighting the urgent need for preventive measures worldwide (Roth et al., 2020).

Currently, there is an unprecedented drive for the use of herbal preparations contemporary medicine. This drive is powered by several aspects, prime among which are their cost-effective therapeutic promise compared to standard modern therapies and the general belief that they are safe (Shaito et al., 2020). *Ocimum Basilicum* L. (OBL) is one of the medicinal plants whose cardiovascular effects have been considered both in the traditional medicine and in the modern scientific literature.

Ocimum Basilicum Linn. (Family: Lamiaceae, the mint family), known as "*Rayhān*" in Unani medicine and is commonly known as sweet basil (Fig 1). Sweet basil is an annual herb with dense foliage and a variety of aromatic components, requires low maintenance, and it is easy to grow in indoor and outdoor settings (Azizah et al., 2023). It is native to India, grows in lower hills of Punjab. Its leaves may taste somewhat like anise, with a strong, pungent, often sweet smell (Miraj & Kiani, 2016). Its seeds, leaves and flowers are used medicinally as well as for culinary purposes (Khare, 2007).

Sweet basil is widely used in Unani medicine, and holds as special place as one of the 50 cardioactive plants mentioned in book "*Risālatul Advia Qalbiya*" (The Treatise on Cardiac Drugs) by *Ibn Sina* (Rahman & Jamal, 2020). In Unani medicine, sweet basil features cardioprotective activity which is attributed to its aromatic and astringent properties. It also possesses exhilarating action due to its moisture (Sina, 1983). Other therapeutic uses in Unani medicine are *Khafaqān* (palpitations), *Wāswās* (anxiety), *Suda'* (headaches) as well as in gastrointestinal disorders (Kabiruddin, 2010). Pharmacological studies have demonstrated diverse cardiovascular as well as other actions such as antioxidant, antihypertensive, anti-thrombotic, anti-arrhythmic, vasorelaxant, anti-platelet, hypoglycemic, cytotoxic and anti-hepatotoxic effects. Moreover, it also shows anti-depressant as well as gastroprotective effect (Miraj & Kiani, 2016; Azizah et al., 2023; Qamar et al., 2023; Kheradmandpour et al., 2020; El-Ghffar et al., 2018).

In this review, a comprehensive traditional and modern pharmacological evidence supporting the cardiovascular benefits of OBL have been put forward. By highlighting its antihypertensive, anti-arrhythmic, and antioxidant properties, the review underscores the potential of sweet basil as a natural remedy for managing cardiovascular diseases. The alignment of traditional Unani

medicine uses with modern scientific findings provides a strong rationale for further investigation into its therapeutic applications.

Figure 1. Leaves of *Ocimum basilicum* Linn

Methodology of Literature review

A comprehensive literature search was conducted to gather data on the cardiovascular effects of *Ocimum basilicum* L. Electronic databases including PubMed, ScienceDirect, Scopus, Google, and Google Scholar were systematically searched. The following key terms and their combinations were employed: "sweet basil," "basil seeds," "*Ocimum basilicum*," along with "antioxidant," "cardioprotective," "hypertension," and "cardiovascular diseases." In addition, classical Unani literature was extensively reviewed to explore traditional perspectives on OBL. Primary references included *Makhzan al-Mufradāt*, *Al-Qānūn fī al-Tibb*, *Risālatul Advia Qalbiya* and *Bustān al-Mufradāt*. Standardized Unani terminologies were adopted from the Standard Unani Medical Terminology published by the Central Council for Research in Unani Medicine (CCRUM) in collaboration with the World Health Organization (WHO) to ensure uniformity and accuracy in classical and modern correlation.

Phytochemistry:

Phytochemical screening shows the presence of phenolic compounds, and flavonoids in it with rosmarinic-acid as the principal phenolic compound (Fathiazad et al., 2012). The extract and essential oil of *O. basilicum* Linn. contain classes of chemical compounds, mainly terpenoids, such as oxygenated sesquiterpenes, oxygenated monoterpenes, sesquiterpene hydrocarbons, monoterpene hydrocarbons, and non-terpene derivatives. (Table 1) The plant is characterized by a rich phytochemical profile, comprising phenylpropanoids (eugenol, methyl eugenol, chavicol, estragole, methyl cinnamate) and a variety of monoterpenes with therapeutic potential, including geraniol, myrtenol, pinene, camphor, and borneol (Azizah et al., 2023). Its essential oil fraction is particularly abundant in linalool (up to 55%), estragole (up to 70%), and eugenol (Khare, 2007). Additionally, the plant contains caffeic acid derivatives, flavonoids, and a diverse array of terpenoids, encompassing oxygenated monoterpenes, oxygenated sesquiterpenes, sesquiterpene hydrocarbons, and monoterpene hydrocarbons (Azizah et al., 2023). (Fig. 2)

Table 1. Phytochemical compounds in *O. basilicum* (Azizah et al., 2023)

Class of compounds	Compounds
Terpenoids	Monoterpene hydrocarbons (α-pinene, β-myrcene, camphene), Oxygenated monoterpenes (linalool, geraniol), Sesquiterpene hydrocarbons, Oxygenated sesquiterpenes.
Phenylpropanoids	Eugenol, methyl eugenol, chavicol (methyl chavicol), estragole, methyl cinnamate
Polyphenols	Caffeic acid, caftaric acid, 3,4-dihydroxyphenylacetic acid, ferulic acid, rosmarinic acid, rutoside (rutin)
Phytosterols	β-sitosterol, stigmasterol, campesterol

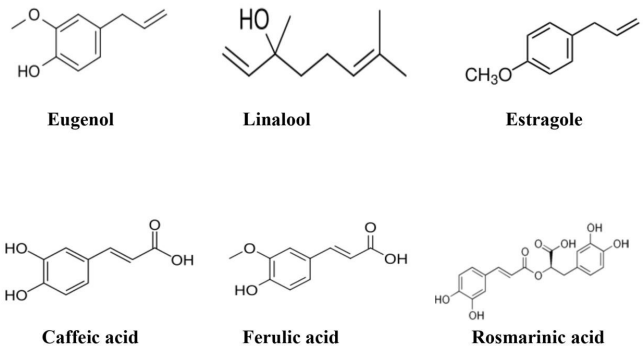

Figure 2. Important phytochemical compounds of *O. basilicum*

Discussion and future potential

The present findings highlight the broad spectrum of phytoconstituents and pharmacological activities of OBL. Phytochemical analysis indicates the presence of diverse bioactive classes such as terpenoids, phenylpropanoids, polyphenols, and phytosterols, each contributing to cardiovascular protection through different mechanisms. (Table 1) Terpenoids like linalool and geraniol are well documented for vasorelaxant and anti-inflammatory actions, while phenylpropanoids such as eugenol and methyl eugenol exert antiplatelet and anti-arrhythmic effects. Polyphenols, including caffeic acid, ferulic acid, and rosmarinic acid, are strong antioxidants with proven cardioprotective potential, whereas phytosterols (β-sitosterol, stigmasterol, campesterol) contribute to cholesterol-lowering activity (Azizah et al., 2023).

The animal studies support the cardioprotective profile of OBL across multiple cardiovascular models. In renovascular hypertensive rats, OBL extract significantly reduced systolic and diastolic blood pressure, comparable to captopril, along with attenuation of cardiac hypertrophy and endothelial dysfunction. These findings suggest antihypertensive efficacy likely mediated by modulation of the renin-angiotensin and endothelin systems. Similarly, in $CaCl_2$-induced arrhythmia, hydro-alcoholic extract of OBL prevented ventricular fibrillation and tachycardia, highlighting its potential anti-arrhythmic action, which may be attributed to ion channel modulation or antioxidant effects of eugenol and terpenoids (Umar et al., 2010; Kheradmandpour et al., 2020). In terms of antithrombotic activity, OBL aqueous extract exhibited dose-dependent inhibition of platelet aggregation and thrombus weight, comparable to aspirin. This finding is of clinical significance as it indicates a potential role in the prevention of thromboembolic disorders without the adverse bleeding risks commonly associated with conventional antiplatelet drugs (Tohti et al., 2006).

The cardioprotective potential of OBL was further evident in isoproterenol-induced myocardial infarction models. Ethanolic extract suppressed ST-segment elevation, improved ventricular contractility, and reduced myocardial necrosis, which aligns with its potent antioxidant activity demonstrated by the reduction of malondialdehyde and improvement in endogenous antioxidant markers. These effects may be primarily mediated through polyphenols such as rosmarinic acid and rutin, which are known free radical scavengers (Fathiazad et al., 2012). Additionally, OBL demonstrated anti-dyslipidemic effects in hypercholesterolemic rats by improving vascular relaxation and suppressing cholester-

ol-induced vascular contractions. This property could be ascribed to the combined effects of phytosterols and polyphenols that regulate lipid metabolism and endothelial function (Amrani et al., 2009).

In the Unani medicine, sweet basil is recognized for its exhilarating and cardiotonic actions, contributing to its use in treating cardiovascular conditions, which has been proven in this review. Moreover, Unani literature indicates that sweet basil is used for the treatment of palpitations, as well as serving as a hepato-tonic, which is consistent with its modern anti-arrhythmic and hepato-protective activities. Some other properties of sweet basil according to Unani medicine include being gastro-tonic and anti-flatulent, which can strengthen the heart indirectly by improving digestion (Kabiruddin, 2010).

Taken together, the evidence strongly supports the role of OBL as a multitargeted cardioprotective agent with antihypertensive, anti-arrhythmic, antiplatelet, cardioprotective, anti-dyslipidemic, and antioxidant properties. Its diverse phytoconstituents synergistically contribute to these effects, providing a rationale for its traditional use and encouraging further investigation in clinical settings to validate its therapeutic potential.

Table 2. Animal studies supporting the cardiovascular effects of *O. basilicum* (OBL)

Study type	Model/population	Intervention	Key findings
Anti-hypertensive	Renovascular hypertensive rats (2K1C Goldblatt model)	OBL extract (100, 200, 400 mg/kg/day) vs. captopril (30 mg/kg/day)	Reduced systolic/diastolic BP by 20/15 mmHg; decreased cardiac hypertrophy and ET-1 levels (Umar et al., 2010)
Anti-arrhythmic	$CaCl_2$-induced arrhythmia in rats	Hydro-alcoholic extract of OBL (100, 200, 400 mg/kg)	Prevented $CaCl_2$-induced arrhythmias in rats by reducing ventricular fibrillation, premature contractions, and tachycardia. (Kheradmandpour et al., 2020)
Anti-platelet activity	Rats with arteriovenous thrombosis model	Aqueous extract of OBL (15, 75, 375 mg/kg)	Dose-dependently inhibited platelet aggregation and reduced thrombus weight, comparable to aspirin. (Tohti et al., 2006)
Cardioprotective activity	Isoproterenol-induced myocardial infarction in Wistar rats	Ethanolic extract of OBL (10, 20, 40 mg/kg, twice daily)	Suppressed ST-segment elevation; improved left ventricular contractility and reduced myocardial necrosis. (Fathiazad et al., 2012)
Anti-dyslipidemic activity	Hypercholesterolemic rats	OBL extract (0.5 g/kg)	Suppressed elevated contractions induced by high cholesterol diet and improved vascular relaxation. (Amrani et al., 2009)
Anti-oxidant activity	Isoproterenol-induced myocardial infarction in rats	Ethanolic extract of OBL (10, 20, 40 mg/kg, twice daily)	Reduced malondialdehyde levels and improved antioxidant markers, indicating antioxidant activity (Fathiazad et al., 2012)

OBL: *Ocimum basilicum* L.

Conclusion:

Ocimum basilicum (sweet basil, *Rayhān*) integrates traditional Unani insights with modern pharmacological evidence, establishing it as a multifaceted cardioprotective herb. While classical texts recognize its cardiotonic and exhilarant properties, contemporary studies confirm its antihypertensive, anti-arrhythmic, antioxidant, and antiplatelet activities, largely driven by bioactive compounds such as linalool, eugenol, rosmarinic acid, and flavonoids. Its indirect gastro-tonic and hepato-tonic effects further support cardiovascular health by promoting digestion, detoxification, and systemic balance. Unani medicine recognizes that cardiac dysfunction can arise not only from direct causes but also from such indirect factors, offering a comprehensive framework that addresses multiple underlying contributors. This holistic perspective highlights a broader therapeutic domain, emphasizing the importance of considering both direct and indirect causes an approach often overlooked in contemporary medicine.

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Conflict of interest

Nil

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