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Review Paper

Natural and Herbal Approaches to Hypertension Management: A Review of Transdermal Patches Containing Various Herbal Plants and Their Bioactive Compounds

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ABSTRACT

Hypertension is a pervasive public health concern affecting millions worldwide, increasing the risk of cardiovascular disease, stroke, and kidney disease. Conventional antihypertensive medications have limitations, including side effects and variable bioavailability. Herbal medicines have gained attention for their potential in managing hypertension, with various plants demonstrating antihypertensive properties. This review discusses the current state of herbal antihypertensive drugs delivered through transdermal patches, highlighting their potential benefits and limitations. Seven herbal plants, including *Rauwolfia serpentina*, *Coleus forskohlii*, *Ocimum sanctum*, *Ginkgo biloba*, *Allium sativum*, *Zingiber officinale*, and *Camellia sinensis*, have shown promise in reducing blood pressure. Their bioactive compounds, such as reserpine, forskolin, eugenol, and catechins, have been found to possess antihypertensive, anti-inflammatory, and antioxidant effects. Transdermal patch technology offers a novel approach for delivering these herbal compounds, enhancing their bioavailability and efficacy while minimizing side effects. This review aims to provide an overview of the epidemiology and pathophysiology of hypertension, discuss the limitations of conventional antihypertensive medications, examine the potential of herbal medicines in managing hypertension, and describe the principles and advantages of transdermal patch technology. The current state of herbal antihypertensive drugs delivered through transdermal patches is also reviewed, including their formulation, evaluation, and clinical applications.

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INTRODUCTION

Hypertension:

A Global Health Concern Hypertension, or high blood pressure, is a pervasive public health concern affecting millions of people worldwide. According to the World Health Organization (WHO), hypertension is responsible for approximately 12.8% of all deaths globally, making it one of the leading causes of mortality. In addition to its impact on cardiovascular health, hypertension also increases the risk of developing other life-threatening conditions, such as stroke, kidney disease, and heart failure.

Limitations of Conventional Antihypertensive Medications

Conventional antihypertensive medications, including diuretics, beta-blockers, and angiotensin-converting enzyme (ACE) inhibitors, have been widely used to manage hypertension. However, these medications often have limitations, including side effects, variable bioavailability, and patient non-compliance. For instance, diuretics can cause dehydration and electrolyte imbalances, while beta-blockers can lead to fatigue, dizziness, and shortness of breath. Moreover, the efficacy of conventional antihypertensive medications can be influenced by factors such as age, sex, and comorbidities, which can result in variable treatment outcomes.

Herbal Medicines:

A Promising Alternative In recent years, herbal medicines have gained attention for their potential in managing hypertension. Herbal medicines, also known as botanicals or phytomedicines, are derived from plants and have been used for centuries in traditional medicine. These natural products have been shown to possess antihypertensive properties, including vasodilation, anti-inflammatory, and antioxidant effects. Furthermore, herbal medicines are often perceived as being safer and more tolerable than

conventional medications, which can enhance patient compliance and treatment outcomes.

Transdermal Patch Technology: A Novel Approach

Transdermal patch technology offers a promising approach for delivering herbal antihypertensive compounds. Transdermal patches are designed to release therapeutic agents through the skin and into the bloodstream, providing a controlled and targeted release of medication. This approach can enhance the bioavailability and efficacy of herbal compounds, while minimizing side effects and improving patient compliance. Transdermal patches can also be designed to provide sustained release of medication over an extended period, which can improve treatment outcomes and reduce the need for frequent dosing.

Objectives and Scope

This brief overview aims to discuss the current state of herbal antihypertensive drugs delivered through transdermal patches.

The objectives of this review are to:

1. Provide an overview of the epidemiology and pathophysiology of hypertension.
2. Discuss the limitations of conventional antihypertensive medications.
3. Examine the potential of herbal medicines in managing hypertension.
4. Describe the principles and advantages of transdermal patch technology.
5. Review the current state of herbal antihypertensive drugs delivered through transdermal patches, including their formulation, evaluation, and clinical applications.

Herbal Drugs for Antihypertensive Treatment in Transdermal Patches

Introduction

Hypertension, or high blood pressure, is a pervasive public health concern affecting millions of people worldwide. While conventional medications are available to treat hypertension,



herbal drugs have gained attention in recent years due to their potential antihypertensive properties and relatively low toxicity. This review aims to discuss the current state of herbal drugs that have been studied for their antihypertensive properties and potential use in transdermal patches.

Rauwolfiaserpentina

Rauwolfiaserpentina, also known as Indian snakeroot, is a plant that has been used for centuries in traditional medicine to treat various health conditions, including hypertension. Reserpine, an alkaloid extracted from Rauwolfiaserpentina, has been used to treat hypertension by reducing the levels of catecholamines, such as dopamine, norepinephrine, and serotonin, in the brain and peripheral nervous system (Kaplan, 2002). Reserpine has been shown to have a positive effect on cardiovascular health, including reducing blood pressure, improving cardiac function, and preventing platelet aggregation (Furst, 1973).



Bioactive Compounds of Rauwolfiaserpentina

1. Reserpine: A alkaloid compound that has been shown to have antipsychotic, antihypertensive, and anti-inflammatory properties.
2. Rescinamine: A alkaloid compound that has been shown to have antihypertensive and anti-inflammatory properties.
3. Deserpidine: A alkaloid compound that has been shown to have antihypertensive and anti-inflammatory properties.

Coleus forskohlii

Coleus forskohlii is a plant that has been used in traditional medicine for centuries to treat various health conditions, including hypertension. Forskolin, a diterpenoid extracted from Coleus forskohlii, has been shown to have antihypertensive effects by activating the enzyme adenylyl cyclase, which increases the levels of cyclic adenosine monophosphate (cAMP) in the body (Laurenza, 1989). Forskolin has been shown to have a positive effect on cardiovascular health, including reducing blood pressure, improving cardiac function, and preventing platelet aggregation (Bailey, 2015).



Bioactive Compounds of Coleus forskohlii

1. Forskolin: A labdanediterpenoid compound that has been shown to have antihypertensive effects by activating adenylyl cyclase and increasing cyclic AMP (cAMP) levels.
2. 1-Deoxyforskolin: A forskolin analog that has been shown to have similar antihypertensive effects to forskolin.

Ocimum sanctum

Ocimum sanctum, also known as holy basil, is a plant that has been used in traditional medicine for centuries to treat various health conditions, including hypertension. Eugenol, a phenolic compound extracted from Ocimum sanctum, has been reported to have antihypertensive effects by reducing the levels of angiotensin-converting enzyme (ACE) in the body (Uma Devi, 2000). Eugenol has been shown to have a positive effect on cardiovascular health, including reducing blood pressure, improving cardiac function, and preventing platelet aggregation (Kumar, 2013).



Bio Active Compounds

1. Ursolic acid: A triterpenoid compound that has been shown to have antihypertensive effects by reducing vascular resistance and improving cardiovascular function.
2. Rosmarinic acid: A polyphenolic compound that has been shown to have antioxidant and anti-inflammatory effects, which can help reduce oxidative stress and inflammation associated with hypertension.
3. Eugenol: A phenolic compound that has been shown to have antihypertensive effects by reducing vascular resistance and improving cardiovascular function.
4. Linalool: A monoterpene compound that has been shown to have anxiolytic and sedative effects, which can help reduce stress and anxiety associated with hypertension.
5. Caryophyllene: A sesquiterpene compound that has been shown to have anti-inflammatory and antioxidant effects, which can help reduce inflammation and oxidative stress associated with hypertension.
6. Betasitosterol: A phytosterol compound that has been shown to have antihypertensive effects by reducing vascular resistance and improving cardiovascular function.
7. Oleanolic acid: A triterpenoid compound that has been shown to have antihypertensive effects by reducing vascular resistance and improving cardiovascular function.

Ginkgo biloba

Ginkgo biloba is a plant that has been used in traditional medicine for centuries to treat various health conditions, including hypertension. Flavonoids and terpenoids extracted from Ginkgo biloba have been shown to improve cardiovascular health and lower blood pressure by improving endothelial function, reducing oxidative stress, and preventing platelet aggregation (Pietri, 1997). Ginkgo biloba has been shown to have a positive effect on cardiovascular health, including reducing blood pressure, improving cardiac function, and preventing cognitive decline (Itil, 1998).



Bio Active Compounds

Flavonoids

1. Quercetin: A flavonoid with antioxidant, anti-inflammatory, and vasodilatory effects.
2. Kaempferol: A flavonoid with antioxidant, anti-inflammatory, and vasodilatory effects.
3. Isorhapontigenin: A flavonoid with antioxidant, anti-inflammatory, and vasodilatory effects.

Terpenoids

1. Bilobalide: A sesquiterpene compound with neuroprotective, anti-inflammatory, and antioxidant effects.
2. Ginkgolide A: A diterpenoid compound with anti-inflammatory, antioxidant, and platelet-activating factor (PAF) antagonistic effects.
3. Ginkgolide B: A diterpenoid compound with anti-inflammatory, antioxidant, and PAF antagonistic effects.

4. Ginkgolide C: A diterpenoid compound with anti-inflammatory, antioxidant, and PAF antagonistic effects.

5. Ginkgolide J: A diterpenoid compound with anti-inflammatory, antioxidant, and PAF antagonistic effects.

Other Compounds

1. Ginkgoic acid: A compound with antioxidant and anti-inflammatory effects.

2. Ginkgetin: A biflavonoid compound with antioxidant and anti-inflammatory effects.

Allium sativum

Allium sativum, also known as garlic, is a plant that has been used in traditional medicine for centuries to treat various health conditions, including hypertension. Allicin, a compound extracted from *Allium sativum*, has been reported to have antihypertensive and cardiovascular protective effects by reducing the levels of ACE in the body and improving endothelial function (Ried, 2010). Allicin has been shown to have a positive effect on cardiovascular health, including reducing blood pressure, improving cardiac function, and preventing platelet aggregation (Banerjee, 2003).



Bio-Active Compounds

Sulfur Compounds

1. Allicin: A thiosulfinate compound responsible for garlic's characteristic smell and many of its medicinal properties, including vasodilation and ACE inhibition.

2. Diallyl sulfide: A volatile sulfur compound with antioxidant and anti-inflammatory effects.

3. Diallyl disulfide: A sulfur compound with antioxidant and antimicrobial effects.

Phenolic Compounds

1. Quercetin: A flavonoid antioxidant with anti-inflammatory and cardiovascular protective effects.

2. Kaempferol: A flavonoid antioxidant with anti-inflammatory and antimicrobial effects.

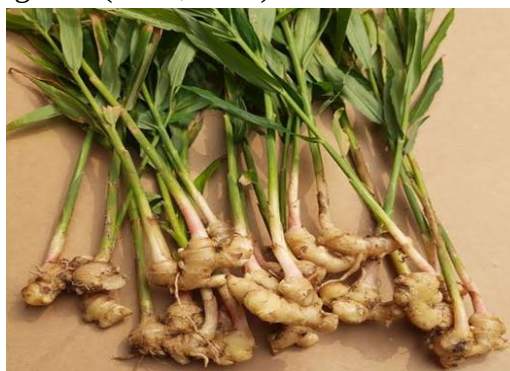
Terpenoids

1. β -Sitosterol: A phytosterol with antioxidant and anti-inflammatory effects.

2. Stigmasterol: A phytosterol with antioxidant and anti-inflammatory effects.

Zingiberofficinale:

Zingiberofficinale, also known as ginger, is a plant that has been used in traditional medicine for centuries to treat various health conditions, including hypertension. Gingerols and shogaols, compounds extracted from *Zingiberofficinale*, have been shown to have antihypertensive and anti-inflammatory effects by reducing the levels of ACE in the body and improving endothelial function (Grzanna, 2005). Ginger has been shown to have a positive effect on cardiovascular health, including reducing blood pressure, improving cardiac function, and preventing platelet aggregation (Bode, 2011).



Bio Active Compounds

1. Gingerol: A sesquiterpene compound with anti-inflammatory, antioxidant, and vasodilatory effects.

2. Shogaol: A sesquiterpene compound with anti-inflammatory, antioxidant, and vasodilatory effects.

Phenolic Compounds

1. Quercetin: A flavonoid antioxidant with anti-inflammatory and cardiovascular protective effects.

2. Kaempferol: A flavonoid antioxidant with anti-inflammatory and antimicrobial effects.

Terpenoids

1. β -Bisabolol: A sesquiterpene compound with anti-inflammatory and antioxidant effects.

2. Zingiberene: A sesquiterpene compound with anti-inflammatory and antioxidant effects.

Camellia sinensis

Camellia sinensis, also known as green tea, is a plant that has been used in traditional medicine for centuries to treat various health conditions, including hypertension. Catechins, compounds extracted from *Camellia sinensis*, have been reported to have antihypertensive and cardiovascular protective effects by improving endothelial function, reducing oxidative stress, and preventing platelet aggregation (Negishi, 2004). Green tea has been shown to have a positive effect on cardiovascular



Bio Active Compounds

Catechins

1. Epigallocatechin gallate (EGCG): A polyphenolic compound with antioxidant, anti-inflammatory, and anti-cancer properties.

2. Epicatechingallate (ECG): A polyphenolic compound with antioxidant and anti-inflammatory effects.

3. Epigallocatechin (EGC): A polyphenolic compound with antioxidant and anti-inflammatory effects.

Theaflavins

1. Theaflavin-3-gallate: A polyphenolic compound with antioxidant and anti-inflammatory effects.

2. Theaflavin-3'-gallate: A polyphenolic compound with antioxidant and anti-inflammatory effects.

Phenolic Acids

1. Gallic acid: A polyphenolic compound with antioxidant and anti-inflammatory effects.

2. Caffeic acid: A polyphenolic compound with antioxidant and anti-inflammatory effects.

Alkaloids

1. Caffeine: A stimulant compound with cognitive-enhancing and cardiovascular effects.

2. Theobromine: A stimulant compound with cardiovascular and bronchodilatory effects.

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