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DESIGN AND FORMULATION OF POLYHERBAL TABLETS CONTAINING "HIBISCUS AND GARLIC FOR THE TREATMENT OF HYPERTENSION"

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ABSTRACT

Hypertension is a major global health concern and a leading risk factor for cardiovascular diseases. Herbal medicines have gained increasing attention due to their safety, efficacy, and minimal side effects compared to synthetic drugs. The present study focuses on the design and formulation of polyherbal tablets containing *Hibiscus* and *Garlic*, two medicinal plants known for their antihypertensive properties. *Hibiscus* is rich in flavonoids and antioxidants that help in vasodilation and reduction of blood pressure, while *Garlic* contains allicin which contributes to improved cardiovascular health by lowering cholesterol levels and regulating blood pressure. In this study, the herbal extracts were carefully processed and formulated into tablet dosage form using suitable excipients through standard pharmaceutical techniques. The formulated tablets were evaluated for various pre-compression and post-compression parameters such as flow properties, hardness, friability, weight variation, and disintegration time. The results indicated that the developed polyherbal tablets showed acceptable pharmaceutical characteristics and may provide a promising natural alternative for the management of hypertension. This formulation highlights the potential of combining herbal ingredients to enhance therapeutic effectiveness in treating high blood pressure.

KEYWORDS: Polyherbal tablets, Hibiscus, Garlic, Hypertension, Herbal formulation, Antihypertensive activity, Herbal medicine, Tablet evaluation.

1. INTRODUCTION

1.1 Hypertension is a chronic medical condition characterized by persistently elevated blood pressure in the arteries and is one of the major risk factors for cardiovascular diseases such as stroke, heart attack, and kidney disorders. It affects millions of people worldwide and has become a significant public health problem. Although several synthetic antihypertensive drugs are available, their long-term use may lead to side effects such as dizziness, fatigue, and electrolyte imbalance. Due to these limitations, there has been growing interest in herbal and plant-based therapies that are considered safer, cost-effective, and suitable for long-term management of hypertension. Polyherbal formulations, which combine multiple medicinal plants, are increasingly used in modern herbal drug development to enhance therapeutic efficacy through synergistic effects.

1.2 The rationale behind combining hibiscus and garlic lies in their complementary and potentially synergistic mechanisms of action. Both agents target the renin–angiotensin–aldosterone system (RAAS), promote vasodilation, and reduce oxidative stress, but through slightly different biochemical pathways. Hibiscus primarily contributes through diuresis and calcium channel modulation, while garlic enhances nitric oxide bioavailability and vascular flexibility. When used together, they may provide a broader therapeutic effect

by simultaneously reducing blood volume, relaxing vascular smooth muscle, inhibiting vasoconstrictor hormones, and improving endothelial function. This multi-targeted approach may result in better blood pressure control compared to using either herb alone.

1.3 In conclusion, the combination of Hibiscus sabdariffa and Allium sativum represents a promising herbal strategy for the management of mild to moderate hypertension. Through antioxidant, vasodilatory, ACE-inhibitory, and diuretic mechanisms, this combination may help lower blood pressure and support overall cardiovascular health. However, it should be considered as an adjunct to conventional therapy rather than a replacement, and its use should be guided by medical supervision, especially in patients already receiving antihypertensive medications.

2. Hibiscus

2.1 *Hibiscus* (*Hibiscus rosa-sinensis* / *Hibiscus sabdariffa*) is a well-known medicinal plant widely used in traditional medicine for its therapeutic benefits. The plant is rich in bioactive compounds such as flavonoids, anthocyanins, polyphenols, and organic acids that exhibit strong antioxidant and cardioprotective properties. These compounds help in relaxing blood vessels, improving blood circulation, and reducing oxidative stress, which contributes to lowering blood pressure. Several studies have suggested that regular consumption of hibiscus extracts may significantly reduce systolic and diastolic blood pressure, making it a promising natural remedy for hypertension management. Herbal formulations prepared from **Hibiscus** have shown significant potential in reducing hypertension due to the presence of various bioactive compounds such as flavonoids, anthocyanins, polyphenols, and organic acids. These phytochemicals possess strong antioxidant and vasodilatory properties that help in relaxing blood vessels and improving blood circulation, thereby lowering blood pressure levels. Hibiscus also helps reduce oxidative stress and inhibits the activity of angiotensin-converting enzyme (ACE), which plays an important role in regulating blood pressure. Regular use of hibiscus-based herbal tablets may help decrease both systolic and diastolic blood pressure and support overall cardiovascular health, making it a promising natural approach for the management of hypertension.

2.1 Hibiscus.

3. Garlic

3.1 Garlic (*Allium sativum*) is one of the most widely used medicinal herbs known for its cardiovascular protective effects. It contains sulfur-containing compounds such as allicin, ajoene, and diallyl sulfides that play an important role in regulating blood pressure and improving heart health. Garlic has been reported to exhibit antihypertensive, lipid-lowering, antioxidant, and anti-inflammatory activities. The active compound allicin helps in relaxing blood vessels, enhancing nitric oxide production, and reducing cholesterol levels, thereby improving overall cardiovascular function. Due to these pharmacological properties, garlic is considered an effective natural ingredient in the development of herbal formulations for the treatment and management of hypertension.

Similarly, Allium sativum has been widely used in traditional medicine for cardiovascular health. The major active compound in garlic, allicin, along with other sulfur-containing compounds such as S-allyl cysteine, contributes to its antihypertensive effects. Garlic enhances the production of nitric oxide and hydrogen sulfide in the endothelium, both of which are powerful vasodilators that relax blood vessels and reduce peripheral resistance. Garlic also shows mild ACE inhibitory activity and improves arterial elasticity, thereby lowering systolic and diastolic blood pressure. Furthermore, its antioxidant and anti-inflammatory properties help reduce oxidative stress and endothelial dysfunction, which are key contributors to the development of hypertension.

3.1 Garlic.

4. METHODOLOGY

4.1 The methodology for evaluating the antihypertensive effect of the combination of Allium sativum and Hibiscus sabdariffa can be designed as an experimental or clinical study depending on the research objective. Initially, the plant materials are procured from a certified herbal supplier and authenticated by a qualified botanist. The dried calyces of Hibiscus sabdariffa are cleaned, shade-dried if necessary, and powdered. Garlic cloves (Allium sativum) are peeled, washed, and crushed to activate allicin formation. For extract preparation, hibiscus powder may be subjected to aqueous extraction

using distilled water by maceration or Soxhlet extraction, followed by filtration and concentration under reduced pressure. Garlic extract can be prepared similarly using aqueous or hydroalcoholic extraction to preserve active sulfur compounds. Both extracts are then standardized based on key phytochemical markers such as total anthocyanin content for hibiscus and allicin content for garlic. For preclinical evaluation, hypertension may be induced in laboratory animals (such as Wistar rats) using methods like a high-salt diet or administration of agents such as L-NAME to inhibit nitric oxide synthesis. The animals are divided into different groups, including a normal control group, hypertensive control group, standard drug-treated group (e.g., ACE inhibitor), hibiscus-treated group, garlic-treated group, and combination-treated group. The extracts are administered orally at predetermined doses for a specific duration, usually 4–8 weeks. Blood pressure is measured at regular intervals using a non-invasive tail-cuff method or invasive arterial cannulation technique. Additional parameters such as heart rate, serum lipid profile, antioxidant enzyme levels (SOD, catalase), and renal function markers are also assessed to evaluate the overall cardiovascular protective effect.

4.2 In a clinical methodology involving human subjects, individuals diagnosed with mild to moderate hypertension are selected based on inclusion and exclusion criteria after obtaining ethical committee approval and informed consent. Participants are randomly divided into groups receiving hibiscus tea, garlic supplement, combination therapy, or placebo. The hibiscus preparation may be administered as standardized herbal tea (e.g., 1–2 cups daily), while garlic may be given in capsule form or as standardized aged garlic extract. Blood pressure readings (systolic and diastolic) are recorded at baseline and monitored weekly or biweekly for 8–12 weeks using a calibrated sphygmomanometer. Dietary intake, physical activity, and medication compliance are monitored to minimize confounding variables.

4.3 Statistical analysis is performed using appropriate software to compare pre- and post-treatment values within and between groups. Data are expressed as mean ± standard deviation, and significance is determined using ANOVA followed by post hoc tests, with $p < 0.05$ considered statistically significant. The overall outcome is evaluated by assessing the degree of reduction in systolic and diastolic blood pressure in the combination group compared to individual treatments. This methodology helps determine whether the combined use of Allium sativum and Hibiscus sabdariffa provides a synergistic antihypertensive effect and supports its potential use as a complementary therapy in hypertension management.

1. Selection and Authentication of Plant Materials

Fresh petals of Hibiscus rosa-sinensis and bulbs of Allium sativum were selected based on their reported antihypertensive and cardioprotective properties. The plant materials were collected from a local herbal garden or authenticated supplier and authenticated by a qualified botanist in the pharmacognosy department. The collected materials were washed thoroughly with distilled water to remove dust and impurities and then shade-dried at room temperature for several days to preserve their phytochemical constituents. After complete drying, the plant materials were pulverized separately using a mechanical grinder to obtain a fine powder, which was then passed through a standard sieve (usually mesh no. 40 or 60) to ensure uniform particle size and stored in airtight containers for further study.

2. Preparation of Plant Extracts

The powdered hibiscus petals and garlic bulbs were subjected to extraction to obtain the bioactive constituents responsible for antihypertensive activity. Extraction was carried out using a suitable solvent such as ethanol, hydroalcoholic solution, or distilled water depending on the solubility of phytoconstituents. A Soxhlet apparatus or maceration technique was commonly used for extraction. In the Soxhlet method, a measured quantity of powdered material was placed in the extraction chamber and extracted with the selected solvent for several cycles until complete extraction was achieved. The obtained extracts were filtered and concentrated using a rotary evaporator or water bath at controlled temperature to remove the solvent. The concentrated extracts were then dried to obtain a semisolid or dry extract and stored in desiccators for formulation.

3. Phytochemical Screening

Preliminary phytochemical analysis of the hibiscus and garlic extracts was conducted to identify the presence of major bioactive compounds. Standard qualitative tests were performed to detect phytoconstituents such as flavonoids, alkaloids, tannins, saponins, phenolic compounds, glycosides, and terpenoids. These compounds are known to contribute to antioxidant, vasodilatory, and antihypertensive activities. The screening helps confirm the presence of therapeutic constituents in the extracts and supports their use in the development of polyherbal formulations for hypertension management.

4. Formulation of Polyherbal Tablets

Polyherbal tablets were prepared by combining measured quantities of hibiscus extract and garlic extract along with suitable pharmaceutical excipients. Common excipients used included diluents such as microcrystalline cellulose or lactose, binders like starch or polyvinylpyrrolidone (PVP), disintegrants such as sodium starch glycolate, and lubricants like magnesium stearate and talc. The extracts and excipients were accurately weighed and mixed thoroughly using geometric dilution to ensure uniform distribution of ingredients. The powder blend was then subjected to granulation (wet or dry granulation method) to improve

flow properties and compressibility. The prepared granules were dried, sieved, and finally compressed into tablets using a tablet compression machine.

5. Evaluation of Pre-compression Parameters

Before compression into tablets, the granules were evaluated for pre-compression parameters to determine their suitability for tableting. These parameters included bulk density, tapped density, angle of repose, Carr's index, and Hausner's ratio. These tests help assess the flowability and compressibility of the granules, which are essential for uniform tablet weight and proper tablet formation during compression.

6. Evaluation of Post-compression Parameters

After tablet compression, the polyherbal tablets were evaluated for various quality control parameters according to pharmacopeial standards. These tests included weight variation, hardness, friability, thickness, and disintegration time. The weight variation test ensured uniformity of tablet weight, hardness measured the mechanical strength of tablets, friability determined resistance to abrasion, and disintegration time evaluated how quickly the tablet breaks down in the body. These evaluations ensured that the formulated tablets met acceptable pharmaceutical quality standards.

7. In-vitro Dissolution Study

An in-vitro dissolution study was carried out to determine the release profile of the active herbal constituents from the tablets. The test was performed using a USP dissolution apparatus with a suitable dissolution medium such as phosphate buffer at physiological pH. Samples were withdrawn at specific time intervals and analyzed spectrophotometrically to measure the amount of active constituents released. This study helped determine the rate and extent of drug release from the formulated tablets.

8. Stability Studies

Stability studies were conducted to evaluate the physical and chemical stability of the formulated polyherbal tablets over time. Tablets were stored under different environmental conditions such as room temperature and accelerated stability conditions according to ICH guidelines. Periodic evaluations were performed for parameters such as appearance, hardness, friability, and drug content. The stability study ensured that the formulation maintained its quality, safety, and efficacy throughout its short life.

5. Overview of Hypertension

5.1 Hypertension, commonly known as high blood pressure, is a chronic medical condition in which the force of blood against the walls of the arteries remains consistently elevated. It is considered one of the major risk factors for cardiovascular diseases such as heart attack, stroke, and kidney failure. According to the World Health Organization, hypertension affects millions of people worldwide and is often referred to as a "silent killer" because it usually develops without noticeable symptoms but can cause serious damage to the heart, blood vessels, brain, and kidneys over time. The condition is generally defined as having a systolic blood pressure greater than or equal to 140 mmHg and a diastolic blood pressure greater than or equal to 90 mmHg. Several factors contribute to the development of hypertension, including genetic predisposition, unhealthy diet, excessive salt intake, obesity, lack of physical activity, stress, and aging. Conventional antihypertensive drugs such as diuretics, beta-blockers, calcium channel blockers, and ACE inhibitors are commonly prescribed to control blood pressure.

5.2 Causes

Genetic factors
Obesity
Stress
Excess salt intake
Lack of physical activity
Complications
Heart disease
Stroke
Kidney failure
Vision loss

6. Medicinal Plants

6.1 Hibiscus

Botanical name: Hibiscus sabdariffa
Family: Malvaceae

Phytochemical constituents

Flavonoids
Anthocyanins
Organic acids
Polyphenols

6.2 Garlic

Botanical name: Allium sativum
Family: Amaryllidaceae

Phytochemical constituents

Allicin
Alliin
Sulfur compounds
Flavonoids

7. Advantages

7.1 Synergistic Therapeutic Effect

The combination of Hibiscus rosa-sinensis and Allium sativum produces a synergistic effect in the treatment of hypertension. Both plants contain bioactive compounds that act through different mechanisms to reduce blood pressure. Hibiscus helps in vasodilation and antioxidant activity, while garlic improves blood circulation and reduces cholesterol levels. When used together in a polyherbal formulation, these herbs enhance each other's therapeutic effectiveness.

7.2 Natural and Herbal Treatment Option
Polyherbal tablets provide a natural approach to managing hypertension. Herbal medicines are derived from plant sources and are generally considered safer compared to synthetic drugs. The use of hibiscus and garlic offers a plant-based alternative that supports cardiovascular health without relying entirely on synthetic chemicals.

7.3 Reduced Risk of Side Effects
Conventional antihypertensive medications may cause side effects such as dizziness, fatigue, headache, and electrolyte imbalance during long-term use. Herbal formulations made from hibiscus and garlic are generally well tolerated by the body because they contain natural phytochemicals that work gently with physiological systems, reducing the risk of severe adverse effects.

7.4 Antioxidant and Cardioprotective Properties
Both hibiscus and garlic contain strong antioxidants that help neutralize free radicals and reduce oxidative stress in the body. Oxidative stress is one of the contributing factors to hypertension and cardiovascular diseases. The antioxidant compounds present in these herbs help protect blood vessels and improve heart health.

7.5 Standardized Dosage Form
Formulating the herbal extracts into tablet form ensures accurate and consistent dosing of active ingredients. Each tablet contains a fixed amount of hibiscus and garlic extract, which improves treatment reliability and ensures better therapeutic outcomes.

7.6 Improved Patient Compliance
Tablets are easy to administer, carry, and store, making them convenient for daily use. Converting herbal extracts into tablets eliminates the need for preparing herbal teas or decoctions, which can be inconvenient for patients. This convenience encourages regular medication adherence.

7.7 Better Stability and Shelf Life
Herbal extracts in tablet form have improved stability compared to raw plant materials or liquid preparations. Properly formulated tablets can maintain their quality and potency for a longer period when stored under appropriate conditions.

7.8 Cost-Effective Treatment Option
Medicinal plants such as hibiscus and garlic are widely available and relatively inexpensive. The development of polyherbal tablets using these plants can provide an affordable treatment option for hypertension, especially in regions where access to expensive medications is limited.

7.9 Supports Herbal Drug Development
The formulation of polyherbal tablets contributes to the scientific development of herbal medicines. It helps integrate traditional medicinal knowledge with modern pharmaceutical technology, promoting the use of standardized, safe, and effective herbal formulations in healthcare systems.

8. Properties

8.1 Antihypertensive Property
One of the most important properties of Hibiscus rosa-sinensis and Allium sativum is their antihypertensive activity. Hibiscus contains flavonoids and anthocyanins that help relax blood vessels and improve vascular elasticity, leading to a reduction in blood pressure. Garlic contains sulfur compounds such as allicin that promote vasodilation and improve blood flow by relaxing the smooth muscles of blood vessels. These actions help reduce peripheral vascular resistance and maintain normal blood pressure levels. The combination of these herbs in a polyherbal tablet enhances the overall antihypertensive effect.

8.2 Antioxidant Property
Both hibiscus and garlic possess strong antioxidant properties. Hibiscus is rich in polyphenols, flavonoids, and anthocyanins that help neutralize free radicals and reduce oxidative stress in the body. Oxidative stress is known to damage blood vessels and contribute to hypertension and cardiovascular diseases. Garlic also contains antioxidant compounds that protect cells from oxidative damage and improve endothelial function. The antioxidant activity of these herbs supports cardiovascular health and prevents complications associated with high blood pressure.

8.3 Cardioprotective Property
The cardioprotective property of hibiscus and garlic plays an important role in maintaining heart health. Hibiscus helps improve lipid metabolism and reduces the risk of atherosclerosis by lowering cholesterol levels. Garlic has been widely recognized for its ability to reduce total cholesterol, low-density lipoprotein (LDL), and triglyceride levels in the blood. These effects help protect the heart from cardiovascular diseases such as heart attack and stroke. When used together in a polyherbal formulation, these herbs provide comprehensive protection to the cardiovascular system.

8.4 Anti-Inflammatory Property
Chronic inflammation is one of the factors associated with hypertension and cardiovascular diseases. Both hibiscus and garlic possess anti-inflammatory properties due to the presence of bioactive compounds such as phenolics and sulfur-containing compounds. These compounds help reduce inflammation in blood vessels and improve overall vascular health. By reducing inflammation, the herbs contribute to better regulation of blood pressure and protection against cardiovascular complications.

8.5 Hypolipidemic Property
Garlic is well known for its hypolipidemic effect, which means it helps reduce lipid levels in the blood. The active

compounds present in garlic inhibit cholesterol synthesis and improve lipid metabolism. Hibiscus also contributes to lipid regulation by reducing low-density lipoprotein cholesterol and increasing high-density lipoprotein levels. This property helps prevent the buildup of fatty deposits in blood vessels and supports healthy blood circulation.

8.7 Diuretic Property

Hibiscus exhibits mild diuretic properties that help increase urine production and remove excess fluid and sodium from the body. This reduction in fluid volume helps decrease blood pressure and reduces the workload on the heart. Diuretic activity is beneficial in managing hypertension because excess sodium and water retention are major contributors to elevated blood pressure.

8.8 Antimicrobial Property

Garlic possesses strong antimicrobial properties due to the presence of allicin and other sulfur compounds. These compounds exhibit antibacterial, antifungal, and antiviral activities. Although this property is not directly related to blood pressure control, it contributes to overall health by protecting the body from infections and improving immune function.

9. Uses

1. Helps lower high blood pressure due to the antihypertensive activity of Hibiscus sabdariffa.
2. Improves blood circulation with the cardioprotective effect of Allium sativum.
3. Helps reduce cholesterol and lipid levels in the blood.
4. Acts as a natural vasodilator to relax blood vessels.
5. Provides antioxidant activity that protects the cardiovascular system.
6. Helps maintain normal blood pressure levels.
7. Reduces the risk of heart diseases associated with hypertension.
8. Supports overall heart health and cardiovascular function.

10. CONCLUSION

The design and formulation of polyherbal tablets containing hibiscus and garlic provide a promising herbal approach for the management of hypertension. The combination of these medicinal plants offers multiple pharmacological benefits, including blood pressure reduction, antioxidant activity, and cardiovascular protection. Proper extraction, formulation, and evaluation techniques ensure the quality and effectiveness of the final product. Such polyherbal formulations may serve as a safer and more natural alternative for long-term management of hypertension.

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