Original Research Article

An Assessment of Antihypertensive & Anti-hyperlipidemic Activity of *Allium sativum* and *Rauwolfia serpentine in hypertension and high Fat Induced Rat Model*

Abstract

Introduction: Hypertension (high blood pressure) is an increasingly important global medical and public health problem that is linked to a higher risk of developing cardiovascular disease. Researchers in both developed and developing nations have identified it as one of the most widespread diseases currently present. The investigators are focusing on plants for better, safer, more affordable, and more effective alternatives due to unwanted risks and negative effects of synthetic pharmaceuticals. *Allium sativum* possesses anticarcinogenic, antioxidant, antidiabetic, renoprotective, anti-atherosclerotic, antibacterial, antifungal, and antihypertensive properties while *Rauwolfia serpentina* is known to possess pharmacological actions such as hypnotic effect, sedative effect, antihypertensive activity, and anti hypercholesteremic activity. **Method:** Sixty rats were divided into six groups, each containing ten rats. With the exception of the negative control group, rats from all groups were given 1% NaCI solution as water and high fat diet as food to induce hypertension. After that, among the six groups one group was treated with *Allium sativum*, one group with *Rauwolfia serpentina* and one with the mixture of *Rauwolfia serpentina* and *Allium sativum*. **Result and discussion:** In case of lipid profile and blood pressure (systolic blood pressure, diastolic blood pressure, and mean blood pressure) both *Rauwolfia serpentina* and *Allium sativum* significantly ($p<0.05$) reversed disturbed pathological state, when compared with disease control group. However, *Rauwolfia serpentina* demonstrated the highest degree of activity for anti-hypertensive activity (Mean Blood Pressure 89.79±5.84 mmHg) and *Allium sativum* is more potent for controlling abnormal lipid profile (Total Cholesterol 125.39±5.59). **Conclusion:** Therefore, this study provides scientific evidence that *Rauwolfia serpentina* and *Allium sativum* have considerable anti-

hypertensive and anti-lipidemic activities. More research needs to be done on these plants to isolate particular therapeutic constituents, so that it can be applied more precisely and accurately to mitigate the respective disease.

Keywords: Hypertension, *Allium sativum*, *Rauwolfia serpentina*, rat, anti-hypertensive activity, anti-lipidemic activity.

1. INTRODUCTION

One of the most severe non-communicable diseases and a global shared health issue is hypertension (HTN), represented as raised blood pressure over standard ranges. According to the most recent appraisals, 1.39 billion adults worldwide (31.1%) have hypertension, with two-thirds residing in low- and middle-income nations (16*)*. High blood pressure is a factor in about 7.5 million fatalities yearly, or 12.8% of all deaths worldwide. In 2025, 1.56 billion adults are expected to have high blood pressure (27). The intricate interaction of environmental, pathophysiological, and hereditary aspects that impact several approaches is involved in the etiology of hypertension (19).

Many drugs like calcium channel blockers,beta-blockers, and Angiotensin-converting enzyme (ACE) Inhibitors are used as antihypertensive agents. The reduction in cardiac output caused by bradycardia is one of the most crucial reasons for lowering mean blood pressure, according to the several mechanisms of action proposed to explain the antihypertensive activity of beta-blockers. Some examples of beta blockers are atenolol, bisoprolol (13). Calcium channel blockers (CCBs) prevent the movement of extracellular calcium through cell wall-spanning ion-specific channels. Verapamil and amlodipine are two examples of calcium channel blockers (CCBs) (7).

Inhibitors of the angiotensin-converting enzyme (ACE) lower blood pressure by relaxing blood arteries. Valsartan and captopril are just a couple of instances of ACE Inhibitors (14). These antihypertensive agents frequently have dose-dependent side effects and may cause postural hypotension, dizziness, syncope, headaches, lethargy, or other symptoms due to a rapid drop in blood pressure (3). Beta-blockers may exacerbate glucose intolerance while masking the symptoms of hypoglycemia, hyponatremia, hypokalemia, hypovolemia, and, to a lesser extent, hyponatremia, metabolic alkalosis, hypotension, urgent urination, which is a potentially fatal adverse effect of the drug, and edema in the ankles or feet are some of the common side effects of these medications (11). Additionally, these treatments are extremely pricey, placing a strain on the general populace's finances and endangering the success of the treatment cycle.

Due to unwanted risks and negative effects of synthetic pharmaceuticals, we have a pressing need to use a different, naturally available medications or herbal treatments which have fewer negative effects. Around the world, numerous medicinal plants or herbal medicines have been reported to exert pharmacological properties due to their phytoconstituents such as glycosides, alkaloids, saponins, steroids, flavonoids, tannins, and terpenoids (8). Eighty percent of the

world's population now relies heavily on traditional medicines for their major source of healthcare (9). Herbal medicines are less expensive and a variety of therapeutic benefits are provided by the bioactive substances present in medicinal plants. Consequently, a single plant may be used to cure a number of diseases. Furthermore, genetic modification can be utilized to either increase or decrease the concentration of a certain plant component (25).

Hypertension is treated with a broad spectrum of medicinal plants, including *Carum copticum* (Ajwain), *Nigella sativa* (Black Cumin), *Vitex doniana* (Black plum), *Elettaria cardamomum* (Cardamom), *Zingiber Officinale* (Ginger), and so on are used (10).

Allium sativum, also known as garlic, is the second-most extensively cultivated plant in the *Alliaceae* family and is frequently utilised in the form of spice, additive, and traditional medicine (1). It is thought that Western China, Kazakhstan, and Uzbekistan are the countries of origin for this very scented bulb crop. China, Korea, India, the United States, Spain, Egypt, and Turkey are the top producers worldwide, producing up to 10 million tonnes of garlic annually (28). The phytochemical components such as alkaloid, saponins, flavonoids, glycoside, anthraquinones, tannin and terpenoids are present in ***Allium sativum*** (18). It is rich in biologically active sulfur-containing compounds for instance ajoenes, alliin, allicin, vinyldithiins, and flavonoids like quercetin (the major flavonoid isolated from garlic) (8). Apart from the sulfur containing compounds ***Allium sativum*** comprises of enzymes such as alliinase, peroxidases, and myrosinase and trace elements including selenium, germanium, tellurium along with various amino acids, minerals (1). This plant possesses anticarcinogenic, antioxidant (24) antidiabetic, renoprotective, anti-atherosclerotic, antibacterial, antifungal (5), and antihypertensive properties (2). ***Allium sativum*** produces antihypertensive effect by enhancing the production of not only hydrogen sulphide (H_2S) but also nitric oxide (NO) that promotes vasodilation and leads to lowering the blood pressure (26). Another compound of garlic known as the gamma-glutamylcysteine, inhibits the angiotensin-converting enzyme (ACE) to decrease the blood pressure (6).

Rauwolfia serpentina is one of the important medicinal plants that have been appropriated in the Ayurvedic medicines to treat a variety of ailments and infections since ancient times (12). The plant belongs to the Apocynaceae family (20) and sometimes known as Sarpagandha, Chandrabagha, Snake root plant, Chotachand, Chandrika and Harkaya etc (15). ***Rauwolfia serpentina*** is endemic to India, Bangladesh and other regions of Asia and is extensively disseminated worldwide in the region of the Himalayas, Indian peninsula, Indonesia, Burma and Sri Lanka. It consists of many phytochemical compounds including alkaloids, flavonoids, tannins, and phenols. It confers various pharmacological actions such as hypnotic effect, sedative effect, antihypertensive activity, and antihypercholesteremic activity (12). ***Rauwolfia serpentina*** roots are utilized in the management of insomnia, gastrointestinal disorders, mental agitation, traumas, epilepsy, anxiety, schizophrenia, and insanity (22, 17). Reserpine, an alkaloid found in this plant, lowers blood pressure via regulating peripheral resistance, cardiac contraction, and heart rate (23). Rescinnamine, another alkaloid of ***Rauwolfia serpentina*** decrease the blood

pressure by inhibiting the angiotensin-converting enzyme (ACE) and then blocks the conversion of angiotensin I to angiotensin II that helps in relaxing the blood vessels which finally leads to reduced blood pressure (12).

The present study was designed to evaluate the therapeutic potential of ***Allium sativum*** and ***Rauwolfia serpentine*** in the treatment of hypertension induced in animal model. Additional research may help to separate and purify the active ingredient from this plant that has anti-hypertensive and cardioprotective properties, perhaps paving the way for the development of novel drugs.

2. Method

2.1 Plant collection and extract preparation

Both the *Rauwolfia serpentina* root and the *Allium sativum* bulb were collected from the University of Dhaka's Botany department's garden. The Department of Botany at the University of Dhaka subsequently verified the specimens. *Rauwolfia serpentina* roots and *Allium sativum* bulbs were shelf dried for 7 days and kept in the oven at 40 degree Celsius for 10 days. Then the dried root and bulb were crushed coarsely. After that, the powdered root and bulb were extracted for a few days using a mixture of 50% ethanol and 50% water. Following every three days, the extract was filtered. In a rotary evaporator operating at low temperature and pressure, the extracted materials were dried. In the end, the necessary pharmacological assays were carried out using the crude residue.

2.2 Drugs and chemicals

Sodium chloride (NaCl) and ethanol were bought from the sigma company, USA. Lisinopril, a common hypertension medication, was received as a gift sample from Incepta Pharmaceutical Ltd.

2.3 Experimental animal procurement, nursing, and grouping

Total 60 male rats weighing between (125-200)gm were purchased from Jahangirnagar University, Savar, Dhaka, Bangladesh. They were all housed in a carefully monitored setting (temperature 25 ± 3ºC, relative humidity 55 ± 5%, and 12h light/dark cycle) at the Institute of Nutrition & Food Science at the University of Dhaka. With the exception of the negative control group, rats from all groups were treated with 1% NaCI solution (4) as water and high fat diet as food. High fat diet consists of 40% lipid (Milk powder 10%, ghee 30%, mutton fat 40%, coconut oil 10%, and butter 10%), 25% protein (dry powdered prone 40%, dry boiled mutton 20%, cheese 20%, and egg 20%), and 35% carbohydrate (boiled corn 2% and fructose 98%). Prior to the experiment, each animal was kept in this environment for a minimum of one week. The Institutional Animals Ethics Committee's (IEAC) guidelines were followed for conducting all of the experimental methods.

Sixty rats were constantly dispensed to 6 groups of ten rats in each. Each group consists of 4 rats weighing between (126-150) gm, 4 rats weighing between (151- 175) gm, and 2 rats weighing between (176-200) gm. In all experiments, rats were randomly picked for each group.

2.4 Evaluation of anti-hypertensive activity

Table (1): Group specification, treatment species and dose treatment species of different rat groups.

For this experiment, 60 rats were randomly picked and equally divided into six groups.

Group Number	Group Specification	Treatment species	Dose Treatment species (mg/kg)
1	Negative control	Physiological Saline	10 ml/kg
2	Disease control	No treatment	N/A
3	Disease + Lisinopril	Lisinopril	5
4	Disease + Allium sativum	Allium sativum	1000
5	Disease + Rauwolfia serpentina	Rauwolfia serpentina	1000
6	Disease + Allium sativum + Rauwolfia serpentina	Allium sativum + Rauwolfia serpentina	500+500

2.5 Statistical Analysis

All of our results (raw data) were collected and analyzed on a large sheet employing the MS Excel program and are divided into different categories according to various research criteria. Descriptive statistics were applied to the data, and the findings were presented as mean ± SD. To calculate the statistical significance of the inter-group heterogeneity on the basis of several biological characteristics, we used the "One Way Anova Test" feature of the SPSS 1600 program. Though the "p" value that was identified as less than 0.05 ($P < 0.05$), we consider the occurrences to be statistically significant.

2.6 Experimental guideline

All ethical standards outlined in the Declaration of Helsinki 2013, were followed while conducting the experiments. The Swiss Academy of Sciences and the Swiss Academy of Medical Sciences' guiding principles were followed when handling and caring for animals. The Guidelines for the Euthanasia of Animals: 2013 version were followed for euthanizing animals.

3. Results

In our study, we assessed the systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean blood pressure, serum lipid profile, and the anti–hypertensive activity of *Allium sativum* and *Rauwolfia serpentina*.

3.1 Measurement of blood pressure:

Table (2): Measurement of Blood Pressure of Control

Group	**Mean Blood Pressure**	**Systolic mmHg**	**Diastolic mmHg**
Negative Control	85.68±6.33	108.6±8.23	74.23±4.95
Positive Control	114.58±9.14	139±9.59	102.37±5.48
Rauwolfia serpentina	89.79±5.84*	114.45±7.46*	77.46±5.38*
Allium sativum	99.66±5.47*	126±8.49*	86.49±4.93*
Rauwolfia serpentine+ Allium sativum	97.88±7.32*	121.29±6.45*	86.18±5.90*

Table 2 presents the blood pressure readings of various groups, with *Rauwolfia serpentina* displaying the highest activity. Its mean blood pressure of 89.79 ± 5.84 mmHg, systolic pressure of 114.45 ± 7.46 mmHg, and diastolic pressure of 77.46 ± 5.38 mmHg surpass those of the other groups.

3.2 Measurement of Lipid Profile

Table (3): Measurement of Lipid Profile

Group	**Total Cholesterol**	**HDL**	**LDL**	**Triglyceride**
Negative Control	94.37±7.41	70.39±6.32	37.49±6.49	67.5±5.59
Positive Control	187.32±11.29	46.91±3.62	93.23±8.94	109.37±8.93
Rauwolfia serpentina	155.62±8.90*	54.54±4.69*	67.49±4.92*	102.4.20±9.43*
Allium sativum	125.39±5.59*	61.23±6.29*	50.33±5.60*	89.59±4.63*
Rauwolfia serpentine+ Allium sativum	142.52±7.62*	59.29±4.92*	56.85±4.97*	96.77±7.90*

Table 3 displays the lipid profile readings of different groups. Among them, *Allium sativum* had the greatest activity with total cholesterol level of 125.39±5.59, a HDL level of 61.23±6.29, LDL level of 50.33±5.60 and a Triglyceride level of 89.59±4.63.

Table (4): P-values for three different test group.

Specification	Rauwolfia serpentina	Allium sativum	Rauwolfia serpentine+ Allium sativum
Total Cholesterol	0.00	0.00	0.00
HDL	0.034	0.00	0.012
LDL	0.00	0.00	0.00
Triglyceride	0.039	0.010	0.015
Mean Blood Pressure	0.00	0.024	0.037
Systolic mmHg	0.011	0.028	0.027
Diastolic mmHg	0.00	0.024	0.024

Table (4) demonstrates significant ($p<0.05$) reductions in blood pressure and lipid profile with the use of Rauwolfia serpentina, Allium sativum, and their combination when compared to the disease control group.

4. Discussion

We conducted a pilot study before the research while performing the literature review. The rats were divided into two groups and each group consists of three rats. Following the onset of the illness, one group received treatment with *Allium sativum* extract and the other with *Rauwolfia serpentina* extract. Initial dosages of 200 mg each of *Allium sativum* and *Rauwolfia serpentina* extract failed to produce any discernible effects. When the dosage was raised to 400 mg, significant results were discovered. As the dose was increased, the significance increased until it reached 1200 mg, at which point 1000 mg was decided to be the greatest effective amount.

When systolic blood pressure (SBP) and mean blood pressure were measured in group 3, 4, and 5 (Here *Rauwolfia serpentina* is group 3, *Allium sativum* is group 4, and the mixture of *Allium sativum* and *Rauwolfia serpentina* is group 5) significant decreases was observed compared to disease control group. That means both *Allium sativum* and *Rauwolfia serpentina* can impart anti–hypertensive activity, as a result they can control elevated systolic and diastolic blood

pressure. *Rauwolfia serpentina* demonstrated the highest activity among these groups. In comparison to *Rauwolfia serpentina*, the combination of *Allium sativum* and *Rauwolfia serpentina* had comparatively less activity. *Allium sativum* demonstrated the least degree of activity among groups 3, 4, and 5 (even though all the group can decline significantly). This indicates that *Rauwolfia serpentina* is significantly more potent than *Allium sativum* or an amalgam of *Allium sativum* and *Rauwolfia serpentina* for the anti-hypertensive action.

Spectrometric analysis was used to assess the serum levels of triglycerides, high-density lipoproteins, low-density lipoproteins, and total cholesterol. In groups, 3, 4 and 5 serum total cholesterol, low-density lipoproteins and triglycerides decreased significantly when compared with the positive control group. This suggests that the two plants *Rauwolfia serpentina* and *Allium sativum* can produce antihypertensive effects. Because of this, they are able to regulate high levels of triglycerides, high-density lipoproteins, and low-density lipoproteins in the serum. Group 3,4,5 showed that *Allium sativum* provides maximum activity, a mixture of *Rauwolfia serpentina* and *Allium sativum* delivers comparatively less activity, and *Rauwolfia serpentina* gives much less activity (Even though all can decline significantly). This indicates that *Allium sativum* has substantially stronger antihypertensive activity than *Rauwolfia serpentina.*

To conclude, in both measurement of lipid profile and blood pressure marketed drug showed significant activity. In terms of lipid profile measurement, Allium sativum is more potent for controlling abnormal lipid profile, where Rauwolfia serpentina demonstrated the highest degree of activity for anti-hypertensive activity.

5. Conclusion

It may be concluded that the findings in our study have proved that the root of *Rauvolfia serpentina* and the bulb of *Allium sativum* can serve as effective therapeutic agents to treat antihypertensive and antihyperlipidemic. However, *Rauvolfia serpentina* is much more potent for antihypertensive activity than *Allium sativum*. Even though *Allium sativum* significantly decreases antihypertensive activity. On the other hand, compared to *Rauvolfia serpentina*, *Allium sativum* has substantially stronger antihyperlipidemic effects. Despite the fact that *Rauvolfia serpentina* substantially reduces antihyperlipidemic action. From these results, we can assume that either *Rauvolfia serpentina* contains more antihypertensive constituent or this

antihypertensive constituent has greater potency and more binding affinity for particular receptors. Again, it can be said that *Allium sativum* either possesses a higher concentration of antihyperlipidemic components, or these components are more potent and have higher binding affinities for specific receptors. There may also be novel compounds for which *Rauvolfia serpentina* shows antihypertensive activity and *Allium sativum* gives antihyperlipidemic activity. We need a more vigorous research study so that we can discover antihypertensive and antihyperlipidemic drugs from *Rauvolfia serpentina* and *Allium sativum* to induce disease management.

Ethical approval

Research Ethics Committee of the Department of Pharmaceutical Chemistry, Faculty of Pharmacy, University of Dhaka provided ethical approval for the experiment and oversaw the execution of every experiment for this study.

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