

Garlic (*Allium sativum* L.) Bulb Prevents High Blood Pressure in Egg Yolk-Induced Hypertensive Rats

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Abstract: The aim of this study is to access the antihypertensive potential of garlic juice in rats. To achieve this, 30 Wistar rats were divided into three groups of 10 each. Rats in groups 1 and 2 received a special prepared egg feed diet (24 egg yolk mixed with 1 kg of normal rat diet) while those in group 3 received normal feed diet and they served as the control group. Animals in group 2 were administered 3 mL/100g body weight of undiluted garlic juice simultaneously with the feeding. The animals were fed orally for 21 consecutive days and had access to drinking water *ad libitum*. Blood pressure of each of these groups was determined at day 0, 7, 14 and 21 respectively using standard methods. A significant increase was observed in the blood pressure of animals fed with egg formulated diet without garlic juice treatment when compared with those fed with egg formulated diet and treated with garlic juice and control group respectively at $P < 0.05$. However, this effect was not significant when animals fed with egg formulated diet and treated with garlic juice were compared with those in the control group. Results from this study showed that egg yolk causes high blood pressure in animals but the effect was ameliorated by garlic juice administration, thus garlic possesses antihypertensive potential.

Keywords: Antihypertensive potential, blood pressure, egg yolk, garlic juice

I. INTRODUCTION

Cardiovascular diseases (CVD) are growing contributors to global disease burdens, with epidemics of CVD advancing across many regions of the world which are experiencing a rapid health transition [1]. Diet and nutrition have been extensively investigated as risk factors for major cardiovascular diseases like coronary heart disease (CHD) and stroke and are also linked to other cardiovascular risk factors like diabetes, high blood pressure and obesity [1]. Hypertension is defined as the persistent elevation of systolic/diastolic blood pressure over 140/90 mmHg. It is a major risk factor for developing cardiovascular diseases [2]. Although no definite cause is apparent in the majority of hypertension cases (i.e. idiopathic hypertension), a number of underlying pathologies such as hyperactivity of the renin angiotensin system (RAS), inflammation, oxidative stress and impaired vascular relaxation, can contribute to its onset and long-term persistence [3], [4]. Although various pharmaceutical drugs are available for the treatment of

hypertension, management of hypertension often requires lifelong adherence to the medication and is associated with significant adverse side-effects [5]. Thus, there has been a growing interest in using alternative options, such as adoption of a healthy lifestyle with restricted energy and dietary sodium intake, engagement in physical activities and stopping smoking, for prevention and management of hypertension [6], [7].

Blood pressure is regulated through several mechanisms including modification of angiotensin-converting enzyme (ACE) activity and vascular function as well as changes in oxidative status [8]. Antioxidants may decrease blood pressure through decreasing oxidative stress in the body thus preserving the activity of nitric oxide synthase (NOS) as well as increasing nitric oxide (NO) bioavailability. Moreover, the potential interrelations between blood pressure and plasma lipids may contribute to increased coronary heart disease in hypertensive patients [9].

Allium sativum (garlic) has traditional dietetic and medicinal uses as an anti-infective agent [10]. *In vitro* confirmation of the antimicrobial action of fresh and freeze-dried garlic juices against human pathogenic bacteria [11], fungi [12], and viruses [13] supports these applications. Garlic is a hardy perennial member of onion family. Studies explain that it may be originally native to Asia, but has long been naturalized to Europe northern Africa, Mexico and all over the world [14]. In Nigeria, it is known by different names, viz: "Aayu" in Yoruba, "Ayo-ishi" in Ibo and "Tafarunua" in Hausa. This medicinal plant is mainly used as condiments and for stopping in different cooking [15]. The use of higher plants and their juices to treat infections is an ancient practice in herbal medicine. The herbal medicine may be in the form of powders, liquid or mixtures which may be raw or boiled, ointments linings and incision [16]. Traditional medicine is the sum total of knowledge skills and practices based on the theories, beliefs and experiences indigenous to different cultural that are used to maintain health, as well as to prevent, diagnose, improve or treat physical and mental illness. In many developing countries, a large proportion of the population relies on traditional practitioners and their

armamentarium of medicinal plants in order to meet health care needs. *A. sativum* is one of those plants that were seriously investigated over several years and used for century to treat infectious diseases [17]. Because, it is commercial, nutritional and medicinal values garlic is produced world widely.

Naturally occurring plants have played an important role in the discovery of new therapeutic agents. The therapeutic uses include beneficial effects on the cardiovascular system, antibiotics, antidiabetic, anticancer, anti-inflammatory, antimalarial and hypoglycemic and hormone-like effects [18]. But improper perception and use of herbal remedies result in adverse condition on our health. The understanding of consumer and physician on the toxicities, contradiction and drug interaction as well as side effects of herbal remedies is poor. Due to this, several cardiovascular conditions, CNS bleeding, mouth ulcer, dermatitis is observable [19]. Adverse reactions attend because of improper use of garlic, including gastro intestinal upset, platelet dysfunction that produces post-operative bleeding and spontaneous epidural hematoma. And garlic allergy manifest as rhinitis, asthma, anaphylaxis contact dermatitis and pemphigus. Garlic ingredient diallyldisulfide, allicin, and allylpropyldisulfide are causative of allergies with diallyldisulfide being strongest sensitizer [20]. The chemical burns reported are as result of prolonged placement of garlic. Generally training of practitioners who provide herbal medicine and forming national pharmacovigilance centers (or equivalent institutions) that analyses the causes and advert events of improper uses of herbal is crucial in preventing side effect [21]. Recently, Airaodion et al. [22] reported the pharmacotherapeutic activity of *A. sativum* bulb against Gram-positive and Gram-negative bacteria. Ried [23] reported that garlic has the ability to lower blood pressure. This study therefore sought to investigate if garlic has the propensity to prevent rise in blood pressure in egg yolk-induced hypertensive rats.

II. MATERIALS AND METHODS

A. Collection and Extraction of Plant Materials

Fresh garlic bulbs were purchased from a local market in Ibadan, Oyo State, Nigeria and were identified by a botanist. They were cut into small pieces and mashed in a laboratory with a mortar and pestle, and the fluid squeezed out of the resultant slurry.

B. Experimental Design and Animal Treatment

Thirty Wistar rats weighing between 200 and 220 g were used for the experiment. They were acclimatized for seven (7) days during which they were fed *ad libitum* with standard feed and

drinking water and were housed in clean cages placed in well-ventilated housing conditions (under humid tropical conditions) throughout the experiment. All the animals received humane care according to the criteria outlined in the 'Guide for the Care and Use of Laboratory Animals' prepared by the National Academy of Science and published by the National Institute of Health. They were randomly divided into three groups of ten rats each. Animals in groups 1 and 2 received aspecial prepared egg feed diet (24 egg yolkmixed with 1 kg of normal rat diet) while those in group 3 received normal feed diet and they served as the control group. Animals in group 2 were administered 3 mL/100g body weight of undiluted garlicjuice simultaneously with the feeding. The egg yolk formulated-diet has been reported to cause high blood pressure [24]. The animals were fed orally for 21consecutive days and had access to drinking water *ad libitum*. Blood pressureof each of these groups wasdetermined at day 0, 7, 14 and 21 respectively.

C. Determination of Blood Pressure

Blood pressure was determined from the tails ofrats using non-invasive bloodpressure (NIBP) measuring apparatus (IN125,AD Instruments, Sydney, Australia) according to the method described by Airaodion et al.,[24]. Each ratwas placed in NIBP restrainer and appropriatecuff with sensor was then mounted on its tail andwarmed to about 33 – 35 °C.The tail cuff (MLT125/R) was inflated to a pressure well above theexpected systolic blood pressure, i.e., 200 mmHg, and slowly released during which the pulseswere recorded by using Power Lab dataacquisition system and computer running LabChart 5.0 software (Ad Instruments, Sydney,Australia). Systolic blood pressure (SBP), Meanblood pressure (MBP) and heart rate weremeasured directly using pulse tracing whilediastolic blood pressure (DBP) was calculatedfrom SBP and MBP as:

$$DBP = \frac{3MBP - SBP}{2}$$

D. Statistical Analysis

Data were subjected to analysis of variance using Graph Pad Prism. Results were presented as Mean \pm standard deviation. One way analysis of variance (ANOVA) was used for comparison of the means followed by Tukey's (HSD) multiple comparison tests. Differences between means were considered to be significant at $p < 0.05$.

III. RESULTS

The results of effect of garlic juice on blood pressure are presented in figures 1-4.

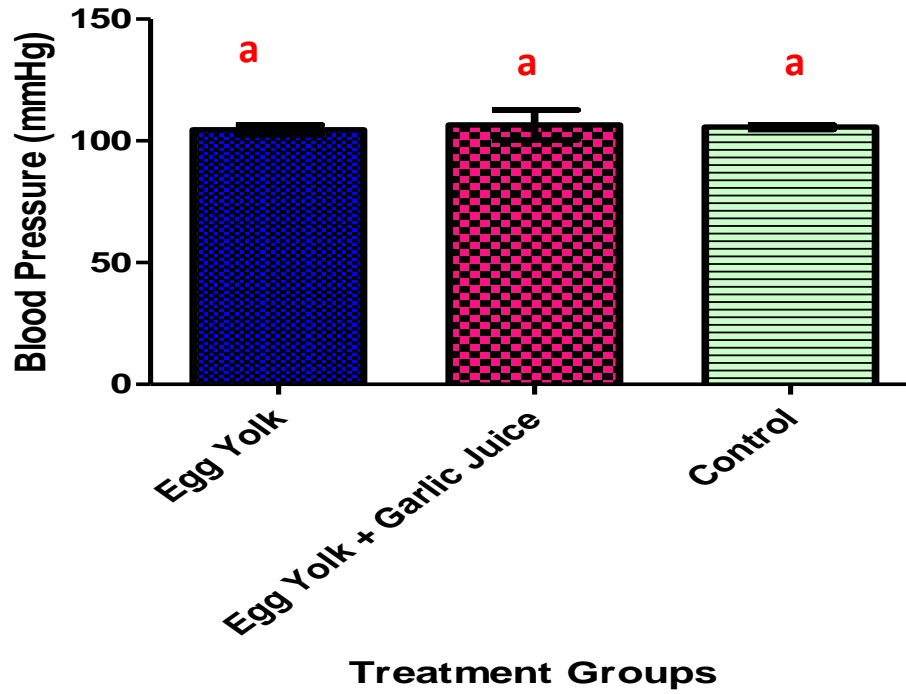


Figure 1: Blood Pressure of Animals Prior to Treatment

Results are presented as mean \pm SEM. Bars bearing different letters are statistically significant at $P < 0.05$

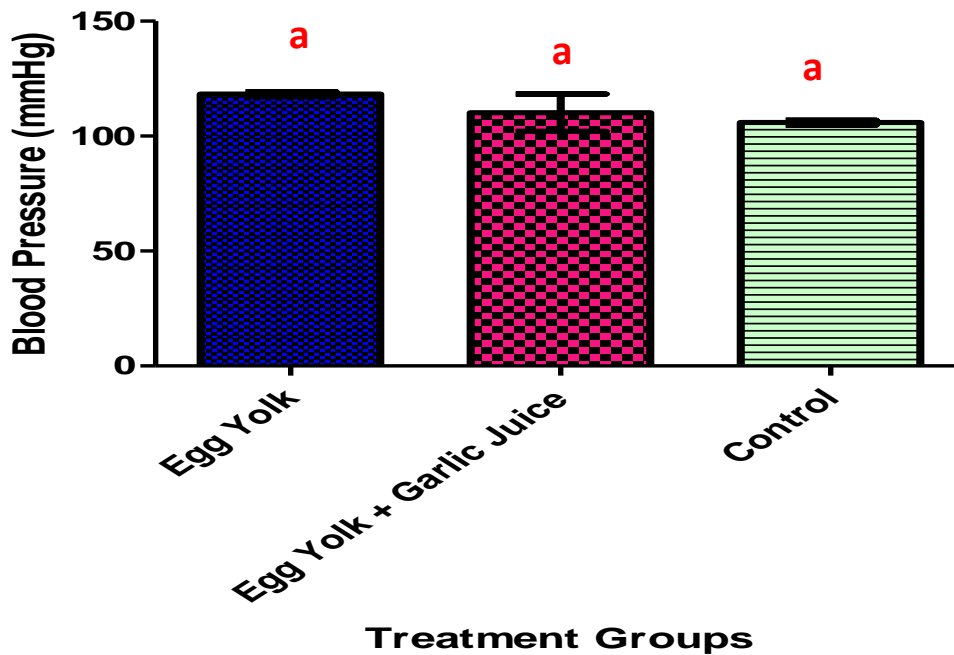


Figure 2: Effect of Garlic Juice on Blood Pressure of Animals after 7 Days of Treatment

Results are presented as mean \pm SEM. Bars bearing different letters are statistically significant at $P < 0.05$

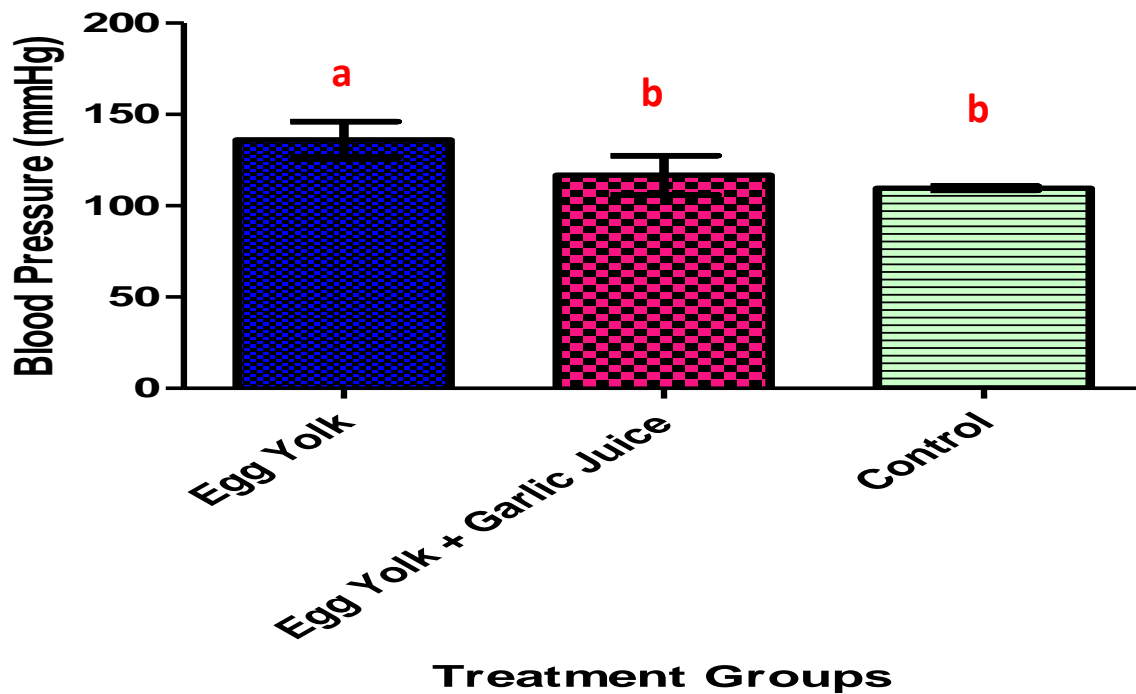


Figure 3: Effect of Garlic Juice on Blood Pressure of Animals after 14 Days of Treatment

Results are presented as mean \pm SEM. Bars bearing different letters are statistically significant at $P < 0.05$

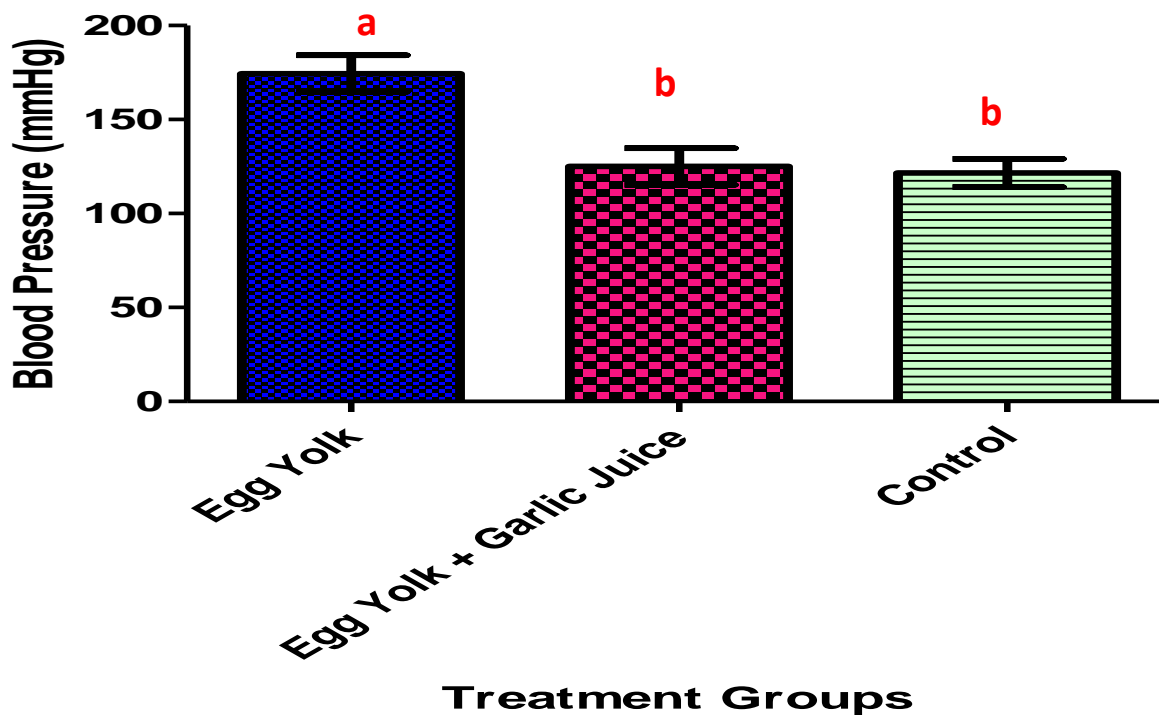


Figure 4: Effect of Garlic Juice on Blood Pressure of Animals after 21 Days of Treatment

Results are presented as mean \pm SEM. Bars bearing different letters are statistically significant at $P < 0.05$

IV. DISCUSSION

High blood pressure is a reliable indicator of premature death [25]. It is a risk factor for stroke, coronary heart disease and renalvascular disease. The control of blood pressure through diet has been the focal point of public health and mass media attention. The method in practice to control high blood pressure is “long-term” drug therapy. Drugs have side effects that can create more clinical problems than are solved [26], [27]. That is why medical professionals worldwide are seeking non-drug treatment and preventative strategies.

The significant increase observed in the blood pressure of animals fed with egg feed diet without treatment with garlic juice showed that egg yolk caused high blood pressure [24]. This is in agreement with the report of Alamgeer et al. [28] who reported the antihypertensive activity of aqueous-methanol extract of *Berberis Orthobotrys* Bien Ex Aitch in rats. Egg yolk has been reported to contain high cholesterol concentration [24], [29]. Cholesterol rich diets have been linked to dyslipidemia which is considered a major risk factor for hypertension [30]. This might be responsible for the sustained increase in blood pressure of animals fed with egg yolk diet without treatment with garlic juice. This is also consistent with the reports of Airaodion et al. [24] and Spence et al. [29].

It is worthy of note that the blood pressure of animals fed with egg yolk formulated diet and treated with garlic juice is not significantly different from those of the control groups despite being fed with egg yolk formulated diet (figures 1-4). A significant decrease was observed in the blood pressure of animals fed with egg yolk formulated-diet and treated with garlic juice when compared with those fed with same diet but untreated with garlic juice at $P < 0.05$. This is similar to the findings of Al-Qattan et al. [31]. Garlic supplements have shown promise in lowering blood pressure in several metaanalyses [32-34], and the blood pressure lowering action of garlic is biologically plausible. Garlic contains a number of active sulfur compounds that have been reported to modulate endothelium-relaxing and constricting factors, leading to blood pressure reduction [35]. Specifically, garlic has been shown to stimulate the production of NO and hydrogen sulphide (H_2S), both gas transmitters leading to vasorelaxation [36], [37], [38]. In addition, others reported that garlic reduced the production of the vasoconstricting factors endothelin 1 and angiotensin II [39], [40].

Garlic contains several bioactive compounds, including allicin, which has antioxidant activity [41]. Some studies showed that allicin could lower BP [42], [43]. Therefore, garlic supplements may ameliorate hypertension by its antioxidant effect. Garlic might also elicit its antihypertensive effects by inhibition of angiotensin-converting enzymes (ACEs). Sharif et al. [44] reported that garlic and allicin could decrease ACE activity in a hypertensive rat model, and they also found that compared with the control group, a significant reduction in SBP was noted in rats treated with garlic. However, several dipeptides extracted from garlic have also

been reported to inhibit ACE and allicin may not be the only compound that has ACE inhibitory activity [45]. Nonetheless, garlic can decrease BP by inhibiting ACE. The antihypertensive potential of garlic juice observed in this study might be due to the activity of allicin.

V. CONCLUSION

Results from this study showed that egg yolk causes high blood pressure in animals but the effect was ameliorated by garlic juice administration, thus garlic possesses antihypertensive potential.

CONFLICT OF INTERESTS

Authors declare that no conflict of interest exist in the publication of this paper.

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