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Comparative Effects of *Garcinia kola* and Garlic Extracts on Some Liver and Haematological Functions in High Salt Diet-Induced Hypertensive Wistar Rats

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Garcinia kola is commonly consumed in Nigeria in social ceremonies, while Garlic is commonly used as a spice in the preparation of certain foods. In this study, the protective effects of extracts of the plants against a high salt diet (8% NaCl) induced hypertension were investigated in rats. Extracts prepared from the plants were subjected to phytochemical screening for acute and sub-acute toxicity studies in rats. In the protective study against salt-induced hypertension thirty-five adult male rats assigned to seven groups of five rats were treated such that, group one served as the normal control group, and group two was the hypertensive control group. Groups three to six were administered graded doses of extracts respectively after induction. While group seven received a combination of the two extracts after induction. Treatment commenced after confirmation

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of hypertension and lasted for two weeks before animals were sacrificed to collect blood for biochemical and haematological analysis. Results obtained showed that G.kola and Garlic feeding produced in rats following liver and haematological assays as values of these parameters in the test groups did not significantly differ from control values ($p<0.05$).

Keywords: Garcinia kola; garlic; biochemical functions; hematological parameters; albino rats.

1. INTRODUCTION

"Bitter kola (Garcinia kola Hackel) belongs to the genus Garcinia (Family: Guttiferae), is an indigenous medicinal tree that is often referred to as a 'wonder plant' because all its parts have medicinal properties" [1]. "Garcinia kola is well-branched, evergreen polygamous trees and is found in moist forests throughout West and Central Africa" [2]. This fruit tree has a regular fruiting cycle and produces fruits every year making it one of the most important trees valued in Nigeria [2], West and Central Africa. "The seeds, leaves and bark of G. kola are very pharmaceutical" (Ashirue et al. 2018). "The seeds have been reportedly used for the treatment of coughs, throat infections, bronchitis, hepatitis (inflammation of the liver), and liver disorders" (Farombi et al. 2005 & Anegbeh et al. 2006). "G.kola seeds have also been found to exhibit inhibitory effects on lipid peroxidation in rat liver homogenate" [1]. "Antwi-Boasiako and Abubakari (2011) state that the seed's bitter stimulants are also used as snake repellent when they are placed around the compound. Other medicinal uses include: purgative, antiparasitic, and antimicrobial. The seeds are used to prevent and relieve colic, cure head or chest colds" (Ashieru et al. 2018). "The seeds constituents include biflavonoids, xanthones and benzophenones and other anti-oxidant and protective properties which could be widely exploited" (Antwi-Boasiako & Abubakari, 2011). The antimicrobial properties of this plant are attributed to the benzophenones, flavanones. According to Orie and Ekon, (1993) as cited by Anegbeh et al. [2], "this plant has shown bronchodilator effect, anti-inflammatory, antimicrobial, antibacterial and antiviral properties".

"Garlic is a bulbous herb used as a food item, spice and medicine in different parts of the world" (Salami et al., 2012). "Allium sativa (garlic) is widely used as flavouring vegetables for its aroma and taste in various types of food worldwide" (Salami et al., 2012). "Garlic is widely recognized as a functional foodstuff that possesses a variety of beneficial effects on human health". (Tattelman, 2005). "Since garlic especially possesses advantageous roles in blood circulation among its physiological effects on the human body, the prevention of cardiovascular disease and other metabolic syndromes by garlic has been well documented". (Rahman & Lowe, 2006 and Banerdee et al., [3]. Several studies have indicated that garlic and its preparation increased fibrinolytic activity (Andrianova et al., 2001) but inhibited platelet aggregation (Rahman, & Billington, 2000 and Allison et al., 2006) as well as lowering blood pressure (Qidwal et al., 2000 and Dhawan et al., 2004) and levels of cholesterol (Durak et al., 2004 and Thompson et al., 2006) in humans. "These effects are advantageous in preventing or ameliorating cardiovascular disorders such as acute myocardial infarction caused by occlusion of blood circulation due to damage to or dysfunction of vascular endothelial cells (VECs), resulting in the formation of blood clot called thrombus" (Hideharu et al., 2007).

The present study was therefore undertaken to investigate the comparative effects of G. kola seed and Garlic on some haematological and liver function indices of Wistar albino rats.

2. MATERIALS AND METHODS

2.1 Plant Materials

Fresh bulbs of *Garlic* and fruits of *Garcinia kola* were obtained from a local vegetable market in Umuahia North Local Government Area, Abia State and were authenticated at the Department of Forestry, College of Natural Resources and Environmental Management, Michael Okpara University of Agriculture, Umudike by Mr. Azuka.

2.2 Animal Materials

Thirty-five adult male rats of the Wistar strain (130-180g) were obtained from the Animal House of the Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture, Umudike, housed in Aluminum cages and allowed to acclimatize for

two weeks to allow for proper adaptation to their new environment and living conditions before commencement of the study. The experimental rats were fed at liberty with vital finisher's mash (Vital feed, Nigeria) and clean water but starved for 12 hours prior to the commencement of the experiment. All animal experiments were conducted in compliance with international guidelines for the care and use of laboratory animals (Orieke *et al*., 2019). The study was conducted in the Department of Biochemistry, Michael Okpara University of Agriculture, Umudike.

2.3 Study Design

The animals used were divided into seven groups, each group consisting of five rats. Group I served as control and received normal feed and distilled water for 14 days. Group II rats received a high salt diet for 14 days. Group III rats received a high salt diet with 500mg/kg of Garlic extracts for 14 days. Group IV rats received a high salt diet with 500mg/kg of G.kola extracts for 14 days. Group V rats received a high salt diet with 1000mg/kg of Garlic extracts for 14 days. Group VI received a high salt diet with 1000mg/kg of G.kola extracts for 14 days. Group VII received a high salt diet with 500 mg/kg of each Garlic and G.kola extract for 14 days.

All the animals in groups I to VII were allowed access to water and rat diet ad libitum throughout the duration of the experiment. In the end the animals were sacrificed and Blood samples were collected by cardiac puncture into EDTA and Plane bottles for haematological and serum biochemical analysis respectively. All biochemical tests were carried out using a Randox commercial test kit in accordance with the protocols outlined by the kit producer, as repeated by Chabra 2018 and Brain et al., 2012.

2.4 Statistical Analysis

All values were expressed as mean±standard error of mean (SEM). Statistical comparisons between group means were performed using analysis of variance (ANOVA), followed by a student t-test. The group means were considered to be significantly different at $p<0.05$.

3. RESULTS

From the results above, the functionality of the liver was confirmed by assessing the plasma levels of alanine (ALT), aspartate (AST), ALP, total protein, albumin and total bilirubin levels. The markers of hepatic values as depicted in the Tables show a significant (p<005) difference in the ALT, AST, ALP, total protein, albumin and total bilirubin levels observed in the plasma of high salt-induced hypertensive rats when compared with the control rats. Oral treatment of High salt-induced hypertensive rats with G.kola and garlic extracts significantly restored the levels of these biomarkers to near normalcy. Administration of G.kola and garlic alone did not affect the liver and kidney function parameters during this study.

Table 1. Effect of treatment on total protein

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	7.17±0.39^{a}	7.40±0.45^{a}	7.11±0.14^{a}
2	Induction only	7.52±0.35^{b}	5.99±0.19^{c}	6.01±0.10^{c}
3	Induction + garlic extract 500mg/kg	6.64±0.38^{a}	6.32±0.40^{b}	6.76±0. 17^{b}
4	Induction + G. kola extract 500mg/kg	6.58±0.35^{a}	6.06±0. 25^{b}	6.82±0.08^{bc}
5	Induction + garlic extract 1000mg/kg	6.86±0.58^{b}	6.34±0.42^{b}	6.98±0. 19^{b}
6	Induction + G. kola extract 1000mg/kg	6.60±0.57^{b}	6.08±0. 47^{b}	6.84±0.10^{b}
7	Induction + Garlic 500 + G.kola 500	6.84±0.72^{b}	6.11±0.57^{b}	6.93±0.13^{bc}

Values are means ± standard deviation for N=5
Values with different superscripts down the column differ significantly ($p< 0.05$)

Table 2. Effect of treatment on albumin

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	3.87±0.34[a]	4.36±0.06[a]	3.99±0.15[a]
2	Induction only	3.89±0.37[b]	3.46±0.31[c]	3.05±0.05[b]
3	Induction + garlic extract 500mg/kg	3.34±0.33[a]	3.37±0.27[b]	3.63±0.07[b]
4	Induction + G. kola extract 500mg/kg	3.99±0.15[bc]	3.39±0.27[b]	3.58±0.09[b]
5	Induction + garlic extract 1000mg/kg	3.56±0.35[b]	3.59±0.29[b]	3.85±0.09[b]
6	Induction + G. kola extract 1000mg/kg	3.40±0.37[b]	3.40±0.29[b]	3.60±0.10[b]
7	Induction + Garlic 500 + G.kola 500	3.97±0.15[bc]	4.34±0.06[a]	3.92±0.10[b]

Values are means ± standard deviation for N=5
Values with different superscripts down the column differ significantly ($p< 0.05$)

Table 3. Effect of treatment on alt (U/L)

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	28.33±1.53[a]	14.33±3.22[a]	30.33±1.53[a]
2	Induction only	30.33±1.53[a]	51.33±6.11[b]	62.00±7.55[c]
3	Induction + garlic extract 500mg/kg	38.00±2.00[b]	56.33±4.73[b]	47.33±2.31[b]
4	Induction + G. kola extract 500mg/kg	42.33±3.22[b]	56.00±2.65[b]	44.33±3.22[b]
5	Induction + garlic extract 1000mg/kg	40.00±3.00[b]	58.35±4.75[b]	49.35±2.33[b]
6	Induction + G. kola extract 1000mg/kg	43.35±3.24[b]	58.00±4.87[b]	46.35±3.24[b]
7	Induction + Garlic 500 + G.kola 500	30.33±1.53[a]	58.00±2.65[b]	44.33±2.52[b]

Values are means ± standard deviation for N=5
Values with different superscripts down the column differ significantly ($p< 0.05$). ALP, Alanine aminotransferase

Table 4. Effect Of Treatment On AST

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	18.33±2.52[a]	18.00±5.00[a]	20.33±2.52[a]
2	Induction only	75.00±6.56[d]	81.00±7.00[b]	77.00±6.56[d]
3	Induction + garlic extract 500mg/kg	48.33±1.53[bc]	74.67±6.03[b]	50.33±1.53[bc]
4	Induction + G. kola extract 500mg/kg	45.67±2.52[a]	82.00±2.00[b]	47.67±2.51[b]
5	Induction + garlic extract 1000mg/kg	48.55±2.55[bc]	76.69±6.05[b]	50.35±2.55[bc]
6	Induction + G. kola extract 1000mg/kg	47.69±2.54[b]	84.00±2.00[b]	49.89±2.53[b]
7	Induction + Garlic 500 + G.kola 500	43.33±1.16[bc]	84.00±2.00[b]	45.33±1.16[b]

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$). AST, Aspartate amino transferase

Table 5. Effect Of Treatment On ALP

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	76.33±3.51^{a}	76.67±4.16^{a}	79.00±3.61^{a}
2	Induction only	134.33±4.73^{d}	128.67±9.45^{b}	136.33±4.73^{d}
3	Induction + garlic extract 500mg/kg	109.33±7.77^{c}	119.67±10.50^{b}	111.33±7.77^{c}
4	Induction + G. kola extract 500mg/kg	106.33±4.51^{bc}	138.67±13.65^{b}	108.33±4.51^{bc}
5	Induction + garlic extract 1000mg/kg	109.35±7.79^{c}	139.69±10.52^{b}	113.35±7.79^{c}
6	Induction + G. kola extract 1000mg/kg	108.35±4.53^{bc}	138.69±13.67^{b}	108.35±4.53^{bc}
7	Induction + Garlic 500 + G.kola 500	97.00±4.58^{b}	140.67±13.65^{b}	99.00±4.58^{b}

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$). ALP, Alkaline phosphatase

Table 6. Effect of treatment on total bilirubin

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	0.48±0.08^{a}	0.50±0.2^{a}	0.51±0.04^{a}
2	Induction only	0.64±0.13^{ab}	1.63±0.12^{b}	1.40±0.08^{c}
3	Induction + garlic extract 500mg/kg	0.80±0.05^{b}	1.52±0.08^{b}	0.77±0.04^{b}
4	Induction + G. kola extract 500mg/kg	0.72±0.05^{b}	1.46±0.07^{b}	0.74±0.05^{b}
5	Induction + garlic extract 1000mg/kg	0.82±0.07^{b}	1.54±0.08^{b}	0.79±0.06^{b}
6	Induction + G. kola extract 1000mg/kg	0.73±0.07^{b}	1.68±0.09^{b}	0.76±0.07^{b}
7	Induction + Garlic 500 + G.kola 500	0.73±0.06^{b}	1.52±0.08^{b}	0.75±0.03^{b}

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$)

Table 7. Effect of treatment on RBC (x10^{3}/mm^{3})

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	4.86±0.18^{a}	5.07±0.24^{a}	6.94±0.12^{a}
2	Induction only	3.68±0.17^{a}	3.94±0.13^{b}	5.70±0.10^{b}
3	Induction + garlic extract 500mg/kg	4.38±0.10^{b}	4.03±0.17^{b}	6.40±0.10^{b}
4	Induction + G. kola extract 500mg/kg	4.48±0.18^{a}	3.86±0.12^{b}	6.50±0.18^{c}
5	Induction + garlic extract 1000mg/kg	4.40±0.12^{b}	4.25±0.19^{b}	6.62±0.12^{c}
6	Induction + G. kola extract 1000mg/kg	4.50±0.20^{b}	3.88±0.14^{b}	6.62±0.18^{c}
7	Induction + Garlic 500 + G.kola 500	4.59±0.90^{b}	5.96±0.12^{b}	6.61±0.09^{c}

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$). RBC, Red blood cells

Table 8. Effect of treatment on HB (g/dl)

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	13.27±0.31[a]	14.37±1.48[a]	15.37±0.40[a]
2	Induction only	11.93±0.93[c]	13.80±0.29[b]	13.47±0.25[b]
3	Induction + garlic extract 500mg/kg	14.07±0.12[b]	13.33±1.15[b]	14.27±0.12[b]
4	Induction + G. kola extract 500mg/kg	14.20±0.36[b]	13.43±0.37[b]	14.37±0.40[a]
5	Induction + garlic extract 1000mg/kg	14.09±0.15[b]	13.35±1.17[b]	14.29±0.14[b]
6	Induction + G. kola extract 1000mg/kg	14.22±0.38[b]	13.45±0.39[b]	14.39±0.42[b]
7	Induction + Garlic 500 + G.kola 500	14.30±0.36[b]	15.50±0.62[c]	14.50±0.36[b]

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$).HB, Hemoglobin

Table 9. Effect of treatment on PCV (%)

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	13.967±0.51[a]	44.00±1.00[b]	15.10±0.52[a]
2	Induction only	38.50±1.15[c]	37.00±1.00[a]	39.60±1.15[b]
3	Induction + garlic extract 500mg/kg	41.93±0.50[b]	37.67±1.52[a]	43.00±0.50 [d]
4	Induction + G. kola extract 500mg/kg	42.30±0.30[d]	36.00±1.00[a]	43.40±0.30 [d]
5	Induction + garlic extract 1000mg/kg	42.95±0.52[d]	37.69±1.53[a]	43.02±0.52 [d]
6	Induction + G. kola extract 1000mg/kg	42.32±0.52[d]	36.02±1.22[a]	43.42±0.32 [d]
7	Induction + Garlic 500 + G.kola 500	42.60±0.46[d]	38.00±1.00[a]	43.67±0.42[d]

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$). PCV, Packed cell volume

Table 10. Effect of treatment on WBC ($x10^3/mm^3$)

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	8.07±0.37[a]	7.90±0.26[a]	8.82±0.12[a]
2	Induction only	8.39±0.23[a]	9.70±0.36[c]	9.43±0.27[b]
3	Induction + garlic extract 500mg/kg	7.85±0.16[a]	8.33±0.15[ab]	8.89±0.21[a]
4	Induction + G. kola extract 500mg/kg	7.91±0.17[a]	8.90±0.44[b]	8.98±0.21[a]
5	Induction + garlic extract 1000mg/kg	7.87±0.18[a]	8.35±0.17[ab]	8.89±0.23[a]
6	Induction + G. kola extract 1000mg/kg	7.93±0.19[a]	8.92±0.46[b]	8.98±0.23[a]
7	Induction + Garlic 500 + G.kola 500	7.95±0.20[a]	9.00±0.26[b]	8.99±0.21[a]

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$). WBC, White blood cells

Table 11. Effect of treatment on PLT (x10^3/mm^3)

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	212.33±10.69^{ab}	158.00±15.72^{a}	220.00±14.73^{ab}
2	Induction only	234.33±4.73^{c}	177.67±14.97^{a}	244.33±4.73^{c}
3	Induction + garlic extract 500mg/kg	203.00±2.00^{a}	188.00±2.00^{a}	215.67±3.05^{ab}
4	Induction + G. kola extract 500mg/kg	210.67±5.03^{ab}	188.67±2.08^{a}	215.67±5.86^{ab}
5	Induction + garlic extract 1000mg/kg	205.02±2.02^{a}	188.22±2.02^{a}	215.69±3.07^{ab}
6	Induction + G. kola extract 1000mg/kg	211.69±5.05^{ab}	188.69±2.08^{a}	217.69±5.88^{ab}
7	Induction + Garlic 500 + G.kola 500	205.33±4.51^{a}	181.00±18.24^{a}	207.33±4.5^{a}

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$). PLT, Platelets

Table 12. Effect of treatment on MCV (pg)

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	23.18±0.95^{a}	29.22±4.42^{a}	21.74±0.51^{a}
2	Induction only	27.33±1.66^{a}	52.86±22.69^{b}	69.47±0.61^{d}
3	Induction + garlic extract 500mg/kg	22.66±2.52^{a}	56.54±2.29^{b}	67.19±0.83^{bc}
4	Induction + G. kola extract 500mg/kg	44.62±16.50^{b}	61.10±6.87^{b}	66.76±1.68^{bc}
5	Induction + garlic extract 1000mg/kg	24.68±2.54^{a}	58.56±2.49^{b}	69.19±0.85^{bc}
6	Induction + G. kola extract 1000mg/kg	46.63±18.52^{b}	62.12±6.89^{b}	68.78±1.88^{bc}
7	Induction + Garlic 500 + G.kola 500	60.66±0.50^{c}	66.93±1.32^{b}	66.03±0.41^{b}

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$)

Table 13. Effect of treatment on MCH (fl)

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	23.18±0.95^{ab}	21.86±0.31^{a}	22.12±0.21^{a}
2	Induction only	27.33±1.66^{bc}	23.45±0.68^{a}	23.63±0.35^{b}
3	Induction + garlic extract 500mg/kg	22.66±2.51^{ab}	23.33±0.76^{a}	22.27±0.27^{a}
4	Induction + G. kola extract 500mg/kg	22.50±3.02^{ab}	23.18±1.07^{a}	21.72±0.10^{a}
5	Induction + garlic extract 1000mg/kg	22.68±2.53^{ab}	23.35±0.78^{a}	22.29±0.29^{a}
6	Induction + G. kola extract 1000mg/kg	22.52±3.24^{ab}	23.38±1.29^{a}	21.74±0.12^{a}
7	Induction + Garlic 500 + G.kola 500	20.83±0.53^{a}	21.86±0.31^{a}	22.50±0.57^{a}

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$)

Table 14. Effect of treatment on MCHC (g/dl)

Group	Treatment	Pre-induction	Post-induction	Post-treatment
1	Normal Control	57.00±9.53[b]	64.82±0.83[a]	101.76±1.70[b]
2	Induction only	31.66±0.95[a]	65.46±1.11[a]	34.01±0.38[a]
3	Induction + garlic extract 500mg/kg	31.16±0.63[a]	65.12±1.13[a]	33.18±0.64[a]
4	Induction + G. kola extract 500mg/kg	31.08±0.70[a]	65.26±1.24[a]	33.10±0.70[a]
5	Induction + garlic extract 1000mg/kg	31.38±0.65[a]	65.14±1.15[a]	33.20±0.86[a]
6	Induction + G. kola extract 1000mg/kg	31.20±0.72[a]	65.28±1.26[a]	33.32±0.72[a]
7	Induction + Garlic 500 + G.kola 500	30.85±0.01[a]	64.90±0.81[a]	33.20±0.57[a]

Values are means ± standard deviation
Values with different superscripts down the column differ significantly ($p< 0.05$)

4. DISCUSSION

Hypertension is a reliable indicator of premature death (ingale et al., 2014). It is a risk factor for stroke, coronary heart disease and renal vascular diseases (Airaodion et al., 2019). 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 (Airaodion et al., 2019). That is why medical professionals worldwide are seeking non-drug treatment and preventative strategies.

Garcinia kola contains dimeric flavonoids [4], which are believed to have many healing benefits. The biological activities of flavonoids include action against allergies, inflammation, free radicals, and hepatoxins (Terashima et al., 2002).

Garlic contains several bioactive compounds, including allicin, which has antioxidant activity [5]. Some studies showed that allicin could lower BP Ali et al., [6] & Dubey et al., [7]. Therefore, garlic supplements may ameliorate hypertension by their antioxidant effect. Garlic might also elicit its antihypertensive effects by inhibition of angiotensin-converting enzymes (ACEs). Sharifi et al.2007 reported that garlic and allicin could decrease ACE activity in a hypertensive rat model.

The significant increase observed in the serum of animals fed with a salt feed diet without treatment with garlic and Garcinia juice showed that salt causes hypertension. This is in agreement with the report of Alamgeer et al., 2013, who reported the antihypertensive activity of aqueous methanol extract of Berberis Orthobotrys Bien Ex Aitch in rats. Salts have been reported to contain high sodium concentrations (Grassi et al., 2002) and Cook N.R. [8]. Excessive sodium consumption (defined by the World Health Organization as >5 g sodium per day World Health Organisation 2012) has been shown to produce a significant increase in BP and has been linked with the onset of hypertension and its cardiovascular complications Weinberger, 1996 [9] & Strazzullo et al., 2009) This might be responsible for the sustained increase in blood pressure of animals fed with high salt diet without treatment with garlic and Garcinia kola juice. This is also consistent with the reports of Airaodion et al, 2019 and Spence et al. [10].

This study examined the effects of Garcinia kola and garlic on high salt-induced hypertensive rats on some liver and haematological function parameters. In the case of the liver function parameters, rats fed with G. kola and garlic extracts were found to exhibit significant differences ($p>0.05$) in serum total bilirubin concentration and activities of AST, ALT, and ALP as compared with control, which indicates the hepatoprotective effect of the extracts in the rat. These results are in accord with those of Jan T et al., 2023 who had shown that G.kola has a hepatoprotective effect.

The population of defensive white blood cells (WBC) can be significantly increased by certain substances which have the ability to boost the immune system (Frandson, 1981). G. kola and Garlic appear to be one such substance as it was

found in this study to induce a remarkable increase ($p<0.05$) in the WBC count of rats (Table 10). The other haematological parameters investigated, notably haemoglobin (Hb) concentration, percentage packed cell volume (PCV) and red blood cell (RBC) count, were, however, found to be non-significantly affected ($p>0.05$) by G. kola and Garlic extracts fed to the rats. This result is in agreement with the report of Esomonu et al. [11] in which the mean Hb, percentage PCV and RBC count of rats fed G.kola extract was found to be non-significantly different ($p>0.05$) from control. This explained that G. Kola and Garlic extract exerted no influence on Hb concentration, percentage PCV and RBC count indicated that the test material did not adversely interfere with the functions of the haematopoietic system. However, there are controversial reports about the effects of *Garcinia Kola and Garlic* on RBC count, Hb, MCV and MCH as positive haematological effects through increasing RBC or induction of macrocytic normochromic anaemia or haemolytic anaemia in some animal species Abdel Gadir[12] Olaniyan[13] Banerjee & Maulik, 2002). The ethanolic extract of *G kola* and garlic has haematological, stimulating, and enhancing effects due to its antioxidant qualities [14]. These findings suggest that it has no harmful effects on the liver's function and may have a beneficial effect, as indicated by its capacity to drastically lower total serum cholesterol and increase WBC count [15-19].

5. CONCLUSION

The results of this study indicated that a high salt diet causes significant hypertension; these findings were reversed by ethanolic G.kola and garlic extract administration. Taken together, the findings from the present investigation demonstrated that the administration of G. kola and Garlic extracts significantly ameliorated hypertension-mediated Liver and haematological functions in high salt-induced hypertensive rats. From this study, it can, thus, be suggested that the extract of *Garcinia kola* and Garlic, possesses an antihypertensive effect possibly due to its antioxidant.

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Manourova, A. Diversity and nutritional characterization of Garcinia kola Heckel in Southwest Cameroon. Master's Thesis, Czech University of Life Sciences Prague, Prague, Czech Republic; 2017.
2. Anegbeh PO, Iruka C, Nikirika C. Enhancing germination of bitter cola (*Garcinia kola*) Heckel: Prospects for agroforesty farmers in the Niger Delta. Science Africa. 2006;(5):38–44.
3. Banerjee SK, Maulik SK. Effect of garlic on cardiovascular disorders: A review. Nutrition Journal. 2002:1(1):1-14.
4. Eleyinmi AF, Bressler DC, Amoo IA, Sporns P, Oshodi AA. Chemical composition of bitter cola (Garcinia kola) seed and hulls. Pol. Journal of Food Nutrition and Science. 2006;(15):395. 65.
5. Prasad G, Sharma VD, Kumar A. Efficacy of garlic (*Allium sativum* L.) therapy against experimental dermatophytosis in rabbits. Indian Journal of Medical Research. 1995;(75):465-467.
6. Ali M, Al-Qattan KK, Al-Enezi F. Effect of allicin from garlic powder on serum lipids and blood pressure in rats fed with a high cholesterol diet. Prostaglandins Leukot Essent Fatty Acids. 2000;(62):253–259.
7. Dubey H, Singha A, Patoleb AM, Tenpe CR. Antihypertensive effect of allicinindexamethasone-induced hypertensive rats. Integrative Medicine Research. Effect of Methanolic Extract; 2017;(6):60-65.
8. Cook NR. Sodium and cardiovascular disease. Journal of Medicine. 2014;37 (1):21-34.
   DOI: 10.1056/NEJMc1412113
9. Weinberger M.H. Salt sensitivity of blood pressure in humans. Hypertension. 1996;2(7):481–490.
   DOI: 10.1161/01.HYP.27.3.481
10. Spence JD, Jenkins DJA, Davignon J. Egg yolk consumption and carotid plaque. Atherosclerosis. 2012;(6):1-5.
11. Esomonu UG., EL-Taalu AB, Anuka JA, Ndodo ND, Salim MA. Atiku MK. Effect of ingestion of ethanol extract of Garcinia kola seed on erythrocytes in Wistar rats. Nig. J. physiol Sci. 2005;20(1-2):30-32.

12. Abdel Gadir EH, Abdel Gadir WS, Adam SEI. Response of Wistar rats to low levels of dietary *Allium cepa*, *Allium sativum* and sodium selenite. Journal of Pharmacological Toxicology. 2006;1(3): 284-288.
13. Olaniyan OT, Meraiyebu AB, Arogbonlo A, Dare JB, Shekins O, Shafe MO. Effects of aqueous extract of garlic (*Allium sativum*) on blood parameters in adult Wistar rats (*Rattus novergicus*). International Journal of Pharmarcological Science Inventory. 2013;2(3):42-45.
14. Atsukwei D, Daniel E, Odeh S, Adams M, Malgwi I, Olih P. Efficacy of *Garcinia kola* seed ethanolic extract on haematological parameters in male Wistar rats. Journal of Advances in Medical and Pharmaceutical Sciences. 2015;3(1):10–23.
DOI: 10.9734/jamps/2015/15305
15. Tamuno-Emine D, Ben-Chioma A, Uwakwe A. Effects of *Garcinia kola* seed on some haematological and serum biochemical parameters of Wistar albino rats. Pyrex Journal of Biomedical Research. 2015;1(4):29–32.
16. Farombi EO, Abolaji AO, Farombi TH, Oropo AS, Owoje OA, Awunah MT. Garcinia kola seed biflavonoid fraction (Kolaviron), increases longevity and attenuates rotenone-induced toxicity in Drosophila melanogaster. Pesticide and Biochemical Physiology. 2018;(145)0:39–45.
17. Farombi EO, Shrotriya S, Surh YJ. Kolaviron inhibits dimethyl nitrosamine-induced liver injury by suppressing COX-2 and iNOS expression via NF-_B and AP-1. Life Science. 2009;(84):149–155.
18. Frandson RD. Anatomy and physiology of farm animals. Lea and Febiger Philadelphia. 1981;229-238.
19. Jan Tauchen, Adela Frankova, Anna Manourova, Irena Valterova, Bohdan Lojka, Olga Leuner. Garcinia kola: A critical review on chemistry and pharmacology of an important West African medicinal plant. Phytochem Rev. 2023;2(2):1305–1351.
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