

COMPARATIVE EFFECTS OF GARCINIA KOLA AND GARLIC EXTRACTS ON THE SOME LIVER AND HEAMATOLOGICAL FUNCTIONS OF HIGH SALT DIET INDUCED HYPERTENSIVE WISTAR ALBINO RATS.

Abstract

Garcinia kolais commonly consumed in Nigeria in social ceremonies, while *Garlic* is commonly used as a spice in preparation of certain foods. In this study, the protective effects of extracts of the plants against 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 35 adult male Wistar Albino rats divided into seven groups of five rats were assigned treatment with group one serving as the normal control and group two, which is the disease control group treated with only the high salt diet. Groups three and four were administered 500 mg/kg body weight of *Garcinia kola* and garlic extracts respectively alongside the induction diet. Also group five and six were administered 1000mg/kgbody weight of *Garcinia kola* and garlic extracts respectively alongside the induction diet, while group seven received a combination of the two extracts alongside induction. Treatment commenced after confirmation of hypertension and lasted for two weeks before animals were sacrificed to collect blood for liver and hematological analysis. Results obtained showed that G.kola and Garlic feeding produced in rats following liver and hematological assays as values of these parameters in the test groups did not significantly differ from control values ($p < 0.05$).

Keywords: *Garcinia kola*, Garlic, Liver Function Markers, Hematological Parameters and Albino rats.

1.0 Introduction

Bitter kola (*Garcinia kola* Hackel) belongs to the genus *Garcinia* (Family: *Guttiferae*), is an indigenous medicinal tree that is often referred to as 'wonder plant' because all its parts have medicinal properties (Manourova et al. 2017). *Garcinia kola* is well branched, evergreen polygamous trees and is found in moist forests throughout West and Central Africa (Anegbeh et al.2006). This fruit tree has a regular fruiting cycle and produces fruits every year making it one of the most important trees valued in Nigeria (Anegbeh et al. 2006), West and Central Africa. The seeds, leaves and bark of *G. kola* are verypharmaceutical (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 (Manourovaet al.2017). Antwi-Boasiako and Abubakari (2011) states 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, 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 Orié and Ekon, (1993) as cited by Anegbeh et al. (2006), this plant has shown bronchodilator effect, anti-inflammatory, antimicrobial, antibacterial and antiviral properties.

Garlic is a bulbous herbs used as 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., 2002). 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.

2.0. 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 male albino 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 experiment. All animal experiments were conducted in compliance international guidelines for care and use of laboratory animals (Oriekeet *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 high salt diet for 14 days. Group III rats received high salt diet with 500mg/kg of Garlic extracts for 14 days. Group IV rats received high salt diet with 500mg/kg of *G.kola* extracts for 14 days. Group V rats received high salt diet with 1000mg/kg of Garlic extracts for 14 days. Group VI received high salt diet with 1000mg/kg of *G.kola* extracts for 14 days. While group VII received high salt diet with 500mg/kg of each Garlic and *G.kola* extracts 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. At the end of the experimental period, the animals were fasted for 12 hours and then sacrificed under chloroform anaesthesia. Blood samples were collected and transferred into:

- i. Test tubes which were appropriately labeled, containing ethylene diamine tetra-acetic acid (EDTA) anticoagulant for determination of haemoglobin concentration, percentage packed cell volume, red and white blood cell count based on the methods described by Dacie and Lewis (1991), modified by Chabra, (2018) and Bain *et al.*, (2012).
- ii. Labelled test tubes without anticoagulant were used to collect Serum by centrifuging at 3,000 rpm for 10 minutes in a wisperfuge centrifuge (model 1384). The serum obtained was used for determination of total cholesterol concentration (using assay kit from Randox Laboratories, UK), total bilirubin concentration (using the method described by Tietz, 1986 and WHO, 2010) and for the assay of the activities of alkaline phosphatase (using assay kit from Randox Laboratories, UK) and alanine (ALT) and aspartate (AST) aminotransferases (Using an assay kits from Randox Laboratories, UK).

3.0. Statistical analysis

All values were expressed as mean \pm standard error of mean (SEM). Statistical comparisons between group means were performed using analysis of variance (ANOVA), followed by student t'test. The group means were considered to be significantly different at $p < 0.05$.

4.0. Results

Table 1: EFFECT OF TREATMENT ON TOTAL PROTEIN

GROUP	TREATMENT	PRE-INDUCTION	POST-INDUCTION	POST-TREATMENT
1	Normal Control	7.17 \pm 0.39 ^a	7.40 \pm 0.45 ^b	7.11 \pm 0.14 ^c
2	Induction only	7.52 \pm 0.35 ^a	5.99 \pm 0.19 ^a	6.01 \pm 0.10 ^a
3	Induction + garlic extract 500mg/kg	6.64 \pm 0.38 ^a	6.32 \pm 0.40 ^a	6.76 \pm 0.17 ^b
4	Induction + G. kola extract 500mg/kg	6.58 \pm 0.35 ^a	6.06 \pm 0.25 ^a	6.82 \pm 0.08 ^b
5	Induction + garlic extract 1000mg/kg	6.86 \pm 0.58 ^a	6.34 \pm 0.42 ^a	6.98 \pm 0.19 ^b
6	Induction + G. kola extract 1000mg/kg	6.60 \pm 0.57 ^a	6.08 \pm 0.47 ^a	6.84 \pm 0.10 ^b
7	Induction + Garlic	6.84 \pm 0.72 ^a	6.11 \pm 0.57 ^a	6.93 \pm 0.13 ^{bc}

Values are means \pm standard deviation.

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 \pm 0.34 ^a	4.36 \pm 0.06 ^b	3.99 \pm 0.15 ^c
2	Induction only	3.89 \pm 0.37 ^a	3.46 \pm 0.31 ^a	3.05 \pm 0.05 ^a
3	Induction + garlic extract 500mg/kg	3.34 \pm 0.33 ^a	3.37 \pm 0.27 ^a	3.63 \pm 0.07 ^b
4	Induction + G. kola extract 500mg/kg	3.99 \pm 0.15 ^a	3.39 \pm 0.27 ^a	3.58 \pm 0.09 ^b
5	Induction + garlic extract 1000mg/kg	3.56 \pm 0.35 ^a	3.59 \pm 0.29 ^a	3.85 \pm 0.09 ^b
6	Induction + G. kola extract 1000mg/kg	3.40 \pm 0.37 ^a	3.40 \pm 0.29 ^a	3.60 \pm 0.10 ^b
7	Induction + Garlic 500 + G.kola 500	3.97 \pm 0.15 ^a	4.34 \pm 0.06 ^b	3.92 \pm 0.10 ^c

Values are means \pm standard deviation.

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 \pm 1.53 ^a	14.33 \pm 3.22 ^a	30.33 \pm 1.53 ^a
2	Induction only	30.33 \pm 1.53 ^a	51.33 \pm 6.11 ^b	62.00 \pm 7.55 ^c
3	Induction + garlic extract 500mg/kg	38.00 \pm 2.00 ^b	56.33 \pm 4.73 ^b	47.33 \pm 2.31 ^b
4	Induction + G. kola extract 500mg/kg	42.33 \pm 3.22 ^b	56.00 \pm 2.65 ^b	44.33 \pm 3.22 ^b
5	Induction + garlic extract 1000mg/kg	40.00 \pm 3.00 ^b	58.35 \pm 4.75 ^b	49.35 \pm 2.33 ^b
6	Induction + G. kola extract 1000mg/kg	43.35 \pm 3.24 ^b	58.00 \pm 4.87 ^b	46.35 \pm 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.

Values with different superscripts down the column differ significantly (p< 0.05).

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 ^b	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±2.544 ^b	84.00±2.00 ^b	49.89±2.53 ^b
7	Induction + Garlic 500 + G.kola 500	43.33±1.16 ^b	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).

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	109.35±7.79 ^c	139.69±10.52 ^b	113.35±7.79 ^c

	extract 1000mg/kg			
6	Induction + G. kola	108.35±4.53 ^{bc}	138.69±13.67 ^b	108.35±4.53 ^{bc}
	extract 1000mg/kg			
7	Induction + Garlic	97.00±4.58 ^b	140.67±13.65 ^b	99.00±4.58 ^b
	500 + G.kola 500			

Values are means ± standard deviation.

Values with different superscripts down the column differ significantly (p< 0.05).

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	0.80±0.05 ^b	1.52±0.08 ^b	0.77±0.04 ^b
	extract 500mg/kg			
4	Induction + G. kola	0.72±0.05 ^b	1.46±0.07 ^b	0.74±0.05 ^b
	extract 500mg/kg			
5	Induction + garlic	0.82±0.07 ^b	1.54±0.08 ^b	0.79±0.06 ^b
	extract 1000mg/kg			
6	Induction + G. kola	0.73±0.07 ^b	1.68±0.09 ^b	0.76±0.07 ^b
	extract 1000mg/kg			
7	Induction + Garlic	0.73±0.06 ^b	1.52±0.08 ^b	0.75±0.03 ^b
	500 + G.kola 500			

Values are means ± standard deviation.

Values with different superscripts down the column differ significantly (p< 0.05).

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 Tables above shows a significant (p<005) difference in the ALT,AST,ALP, total protein, albumin and total bilirubin levels were 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 7: EFFECT OF TREATMENT ON RBC ($\times 10^3/\text{mm}^3$)

GROUP	TREATMENT	PRE- INDUCTION	POST- INDUCTION	POST- TREATMENT
1	Normal Control	4.86 \pm 0.18 ^c	5.07 \pm 0.24 ^b	6.94 \pm 0.12 ^d
2	Induction only	3.68 \pm 0.17 ^a	3.94 \pm 0.13 ^a	5.70 \pm 0.10 ^a
3	Induction + garlic extract 500mg/kg	4.38 \pm 0.10 ^b	4.03 \pm 0.17 ^a	6.40 \pm 0.10 ^c
4	Induction + G. kola extract 500mg/kg	4.48 \pm 0.18 ^b	3.86 \pm 0.12 ^a	6.50 \pm 0.18 ^c
5	Induction + garlic extract 1000mg/kg	4.40 \pm 0.12 ^b	4.25 \pm 0.19 ^a	6.62 \pm 0.12 ^c
6	Induction + G. kola extract 1000mg/kg	4.50 \pm 0.20 ^b	3.88 \pm 0.14 ^a	6.62 \pm 0.18 ^c
7	Induction + Garlic 500 + G.kola 500	4.59 \pm 0.90 ^b	5.96 \pm 0.12 ^c	6.61 \pm 0.09 ^c

Values are means \pm standard deviation.

Values with different superscripts down the column differ significantly ($p < 0.05$).

Table 8: EFFECT OF TREATMENT ON HB (g/dl)

GROUP	TREATMENT	PRE- INDUCTION	POST- INDUCTION	POST- TREATMENT
1	Normal Control	13.27 \pm 0.31 ^a	14.37 \pm 1.48 ^a	15.37 \pm 0.40 ^c
2	Induction only	11.93 \pm 0.93 ^a	13.80 \pm 0.29 ^a	13.47 \pm 0.25 ^a
3	Induction + garlic extract 500mg/kg	14.07 \pm 0.12 ^b	13.33 \pm 1.15 ^a	14.27 \pm 0.12 ^b
4	Induction + G. kola extract 500mg/kg	14.20 \pm 0.36 ^b	13.43 \pm 0.37 ^a	14.37 \pm 0.40 ^b
5	Induction + garlic extract 1000mg/kg	14.09 \pm 0.15 ^b	13.35 \pm 1.17 ^a	14.29 \pm 0.14 ^b
6	Induction + G. kola extract 1000mg/kg	14.22 \pm 0.38 ^b	13.45 \pm 0.39 ^a	14.39 \pm 0.42 ^b
7	Induction + Garlic 500 + G.kola 500	14.30 \pm 0.36 ^b	15.50 \pm 0.62 ^a	14.50 \pm 0.36 ^b

Values are means \pm standard deviation.

Values with different superscripts down the column differ significantly ($p < 0.05$).

Table 9: EFFECT OF TREATMENT ON PCV (%)

GROUP	TREATMENT	PRE- INDUCTION	POST- INDUCTION	POST- TREATMENT
1	Normal Control	13.967 \pm 0.51 ^a	44.00 \pm 1.00 ^b	15.10 \pm 0.52 ^a
2	Induction only	38.50 \pm 1.15 ^b	37.00 \pm 1.00 ^a	39.60 \pm 1.15 ^b
3	Induction + garlic extract 500mg/kg	41.93 \pm 0.50 ^d	37.67 \pm 1.52 ^a	43.00 \pm 0.50 ^d
4	Induction + G. kola extract 500mg/kg	42.30 \pm 0.30 ^d	36.00 \pm 1.00 ^a	43.40 \pm 0.30 ^d
5	Induction + garlic extract 1000mg/kg	42.95 \pm 0.52 ^d	37.69 \pm 1.53 ^a	43.02 \pm 0.52 ^d
6	Induction + G. kola extract 1000mg/kg	42.32 \pm 0.52 ^d	36.02 \pm 1.22 ^a	43.42 \pm 0.32 ^d
7	Induction + Garlic 500 + G.kola 500	42.60 \pm 0.46 ^d	38.00 \pm 1.00 ^a	43.67 \pm 0.42 ^d

Values are means \pm standard deviation.

Values with different superscripts down the column differ significantly ($p < 0.05$).

Table 10: EFFECT OF TREATMENT ON WBC ($\times 10^3/\text{mm}^3$)

GROUP	TREATMENT	PRE- INDUCTION	POST- INDUCTION	POST- TREATMENT
1	Normal Control	8.07 \pm 0.37 ^a	7.90 \pm 0.26 ^a	8.82 \pm 0.12 ^a
2	Induction only	8.39 \pm 0.23 ^a	9.70 \pm 0.36 ^c	9.43 \pm 0.27 ^b
3	Induction + garlic extract 500mg/kg	7.85 \pm 0.16 ^a	8.33 \pm 0.15 ^{ab}	8.89 \pm 0.21 ^a
4	Induction + G. kola extract 500mg/kg	7.91 \pm 0.17 ^a	8.90 \pm 0.44 ^b	8.98 \pm 0.21 ^a
5	Induction + garlic extract 1000mg/kg	7.87 \pm 0.18 ^a	8.35 \pm 0.17 ^{ab}	8.89 \pm 0.23 ^a
6	Induction + G. kola extract 1000mg/kg	7.93 \pm 0.19 ^a	8.92 \pm 0.46 ^b	8.98 \pm 0.23 ^a
7	Induction + Garlic 500 + G.kola 500	7.95 \pm 0.20 ^a	9.00 \pm 0.26 ^b	8.99 \pm 0.21 ^a

Values are means \pm standard deviation.

Values with different superscripts down the column differ significantly ($p < 0.05$).

Table 11: EFFECT OF TREATMENT ON PLT ($\times 10^3/\text{mm}^3$)

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

Values are means \pm standard deviation.

Values with different superscripts down the column differ significantly ($p < 0.05$).

Table 12: EFFECT OF TREATMENT ON MCV (pg)

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

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

Values are means \pm 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 \pm 9.53 ^b	64.82 \pm 0.83 ^a	101.76 \pm 1.70 ^b
2	Induction only	31.66 \pm 0.95 ^a	65.46 \pm 1.11 ^a	34.01 \pm 0.38 ^a
3	Induction + garlic extract 500mg/kg	31.16 \pm 0.63 ^a	65.12 \pm 1.13 ^a	33.18 \pm 0.64 ^a
4	Induction + G. kola extract 500mg/kg	31.08 \pm 0.70 ^a	65.26 \pm 1.24 ^a	33.10 \pm 0.70 ^a
5	Induction + garlic extract 1000mg/kg	31.38 \pm 0.65 ^a	65.14 \pm 1.15 ^a	33.20 \pm 0.86 ^a
6	Induction + G. kola extract 1000mg/kg	31.20 \pm 0.72 ^a	65.28 \pm 1.26 ^a	33.32 \pm 0.72 ^a
7	Induction + Garlic 500 + G.kola 500	30.85 \pm 0.01 ^a	64.90 \pm 0.81 ^a	33.20 \pm 0.57 ^a

Values are means \pm standard deviation.

Values with different superscripts down the column differ significantly ($p < 0.05$).

4.1. Discussion

Hypertension is a reliable indicator of premature death (Ingale et al., 2014). It is a risk factor for stroke, coronary heart disease and renalvascular 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 (Eleyinmi et al., 2006), which is believed to have many healing benefits. The biological activities of flavonoids include action against allergies, inflammation, free radicals, hepatoxins (Terashima et al., 2002).

Garlic contains several bioactive compounds, including allicin, which has antioxidant activity (Prasad et al., 1995). Some studies showed that allicin could lower BP (Ali et al., 2000) & (Dubey et al., 2017). 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. 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 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 *BerberisOrthobotrys* Bien Ex Aitch in rats. Salts have been reported to contain high sodium concentration (Grassi et al., 2002) and (Cook N.R. 2014). 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 onset of hypertension and its cardiovascular complications (Weinberger, 1996 & 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. 2012.

This study examined the effects of *Garcinia kola* and garlic on high salt induced hypertensive rats. In this study, rats fed *G. kola* seed was found to exhibit non-significant differences ($p > 0.05$) in serum total bilirubin concentration and activities of AST, ALT, and ALP as compared with control.

In our study, no significant changes were observed in other hematological parameters. As a result, the extract has a minimal erythropoietic effect but causes moderate leucopenia with lymphocytosis and a decrease in all other WBC lines. The extract significantly decreased the volume of the cell mean cell and hemoglobin cell means in the serum of the animals ($p < 0.05$). 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, 2006; Olaniyan, 2013; Banerjee & Maulik, 2002). The ethanolic extract of *G. kola* and garlic has hematological, stimulating, and enhancing effects due to its antioxidant qualities (Atsukwei et al., 2015). 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 (Tamuno-Emine et al., 2015).

5.0. Conclusion

The results of this study indicated that 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 administration of *G. kola* and Garlic extracts significantly ameliorated hypertension-mediated Liver and Hematological functions in high salt-induced hypertensive rats. From this study, it can, thus, be suggested that extract of *Garcinia kola* and Garlic, possesses antihypertensive effect possibly due to its antioxidant.

References

- 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.
- 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 LeukotEssent Fatty Acids*. 2000;62:253–259.
- Anegbeh, P.O.; Iruka, C.; Nikirika, C. Enhancing germination of bitter cola (*Garcinia kola*) Heckel: Prospects for agroforestry farmers in the Niger Delta. *Science Africa* 2006, 5, 38–44.

- 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.
- Banerjee SK, Maulik SK. Effect of garlic on cardiovascular disorders: a review. *Nutrition Journal* 2002; 1(1): 1-14.
- Cook N.R. Sodium and cardiovascular disease. *Journal of Medicine* 2014;371:2134. doi: 10.1056/NEJMc1412113.
- Dubey H, Singha A, Patoleb AM, Tenpe CR. Antihypertensive effect of allicinindexamethasone-induced hypertensive rats. *Integrative Medicine Research*. 2017;(6):60-65. effect of methanolic extract
- Eleyinmi, A.F.; Bressler, D.C.; Amoo, I.A.; Sporns, P.; Oshodi, A.A. Chemical composition of bitter cola (*Garcinia kola*) seed and hulls. *Pol. Journal of Food Nutrition and Science* **2006**, 15, 395-65.
- Farombi, E.O.; Abolaji, A.O.; Farombi, T.H.; Oropo, A.S.; Owoje, O.A.; Awunah, M.T. *Garcinia kola* seed biflavonoid fraction (Kolaviron), increases longevity and attenuates rotenone-induced toxicity in *Drosophila melanogaster*. *Pesticide and Biochemical Physiology* **2018**, 145, 39–45.
- Farombi, E.O.; Shrotriya, S.; Surh, Y.-J. Kolaviron inhibits dimethyl nitrosamine-induced liver injury by suppressing COX-2 and iNOS expression via NF- κ B and AP-1. *Life Science* **2009**, 84, 149–155.
- Grassi G., Dell’Oro R., Seravalle G., Foglia G., Trevano F.Q., Mancia G. Short- and long-term neuroadrenergic effects of moderate dietary sodium
- Ingale KG, Vyawahare NS, Gautam DT, Bendale ND, Baviskar SK, Bakal RL. The antihypertensive 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 norvegicus*). *International Journal of Pharmacological Science Inventory* 2013; 2(3): 42-45.
- Prasad G, Sharma VD, Kumar A (1995). Efficacy of garlic (*Allium sativum* L.) therapy against experimental dermatophytosis in rabbits. *Indian Journal of Medical Research* 75:465-467.
- Spence JD, Jenkins DJA, Davignon J. Egg yolk consumption and carotid plaque. *Atherosclerosis*. 2012; 1-5.

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.

Weinberger M.H. Salt sensitivity of blood pressure in humans. *Hypertension*. 1996;27:481–490. doi: 10.1161/01.HYP.27.3.481.

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.

UNDER PEER REVIEW