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The Modulatory effects of *Allium cepa* and quercetin on the atherogenic, serum biochemical, and haematologic indices in potassium bromated induced toxicity in male Wistar rats

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ABSTRACT

Background & Aim: This study was designed to evaluate the therapeutic effect of *Allium cepa* on the atherogenic, serum biochemical, and hematologic indices in Wistar rats administered $KBrO_3$.

Experimental: Forty male rats assigned into 8 groups (n=5) in which groups A, B, C, D, and E received distilled water (2 mL), $KBrO_3$ (50 mg/kg), quercetin 70 mg/kg, aqueous extract of *Allium cepa* (AEAC) at 150 mg/kg and 300 mg/kg, respectively. Groups F, G, and H received $KBrO_3$ with AEAC at 150 mg/kg, 300 mg/kg, and quercetin, respectively, on alternate days for 3 months.

Results: The phytochemical analysis of the AEAC revealed the presence and absence of some phytochemical constituents. The Acute toxicity result indicated that AEAC has an LD50 above 5000mg/kg. $KBrO_3$ caused a significant ($P<0.05$) decrease in the haematological parameters relative to the control but administration of $KBrO_3$ with AEAC or quercetin improved the parameters. $KBrO_3$ caused a significant ($P<0.05$) increase in the levels of triglycerides (TG), total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C), but significantly ($P<0.05$) lower level of HDL-C. Treatment with $KBrO_3$ and AEAC or quercetin significantly ($P<0.05$) abrogated these $KBrO_3$-induced alterations. Similar ameliorative effects of AEAC were found in $KBrO_3$-induced alterations in atherogenic indices, such as Castelli's Risk Index I (CRI-1), Castelli's Risk Index II (CRI-II), Atherogenic Coefficient (AC), and Atherogenic Index of Plasma (AIP) indices relative to the control.

Recommended applications/industries: According to the present results, AEAC showed amelioration against $KBrO_3$-induced derangement in the haematological, lipid, and atherogenic indices and it might be helpful in the management of cardiovascular problems.

1. Introduction

Various medicinal plant species contain essential nutrients and pharmacologically important bioactive compounds (Apiamu *et al.*, 2013). Plants with ethnopharmacological importance have been used in traditional medicine for disease management since time immemorial (Usman and Sule, 2014).

The onion has long been used as a nutraceutical and medicinal plant with perceived benefits in preventing

and curing disease. Its chemopreventive effects have been established and it has been used to lower the risk effect of gastric cancer (Zhou *et al.*, 2011), and because it contains phytochemicals such as flavonols, flavones, and isoflavones, its inclusion in the diet is associated with attenuation of plasma low-density lipoprotein (LDL) cholesterol concentration (Arai *et al.*, 2000), and it is found to have hypolipidemic (Kumari and Augusti, 2007) and cardioprotective properties (Schroeter *et al.*, 2006).

Potassium bromate ($KBrO_3$) is a non-nutritional substance widely used as a maturing agent in flour (Chipman *et al.*, 2006). $KBrO_3$ is an efficient oxidizer, flour millers and bakers use it to strengthen and improve their flour as well as to enable the dough to rise more quickly (IARC, 1999). According to Ueno *et al.* (2000), when bromate is consumed, it biotransformed into oxides and radicals which causes important macromolecules in many body tissues to become oxidatively modified (Ahmad *et al.*, 2014). Lipid oxidation and injury to hepatocytes may result in an abnormal lipid profile, especially given the rise in levels of LDL-c, which is thought to be the main contributor to atherosclerosis (Bhardway *et al.*, 2013). Similar to other known risk factors for CVD, significant increases in plasma levels of LDL and VLDL-c are also frequently observed in non-communicable diseases like hypertension and obesity, which have been identified as the primary health issues in the world today (Rakib *et al.*, 2014). It has been reported that different ratios or combinations of these lipid profiles are better indices for detecting high-risk individuals (CVDs) than just the lipid parameters alone (Bhardway *et al.*, 2013). Atherogenic coefficient (AC), atherogenic index of plasma (AIP), and Castelli's risk indices are three ratios of lipid profile indices that have been studied and thought to be markers of lipid atherogenic risk (CRIs). The atherogenic index specifies the degree of the probable rate of atherosclerosis as a marker of CVDs (Khazaal, 2013). According to Koleva *et al.* (2015), calculated lipid fraction ratios are increasingly being used in clinical settings to assess the risk of CVD rather than the more conventional lipid profile parameters.

In this study, we investigated the protective effects of *Allium cepa* extract against $KBrO_3$-induced changes in atherogenic, haematologic, and biochemical indices in male albino rats.

2. Materials and Methods

2.1. Chemicals and reagents

Assay kits for lipid profile: TC, TAG, HDL-c, LDL-c, VLDL–c, and total lipids (TL) concentrations) were purchased from Sun long Biotech co. (Shangyi, Hangzhou, Zhejiang, China). KBrO3 and quercetin were obtained from Sigma-Aldrich, St. Louis MO, USA.All the other chemicals used were of analytical grade.

2.2 Collection and identification of plant material

Allium cepa (Red onion bulb) was procured from Bodija, Ibadan vegetable market, and authenticated at the Department of Botany, University of Ibadan, Nigeria. Voucher specimen identification number UIH 22631 was assigned.

2.3. Preparation of aqueous extract of Allium cepa (AEAC)

The extraction method used was a modification of the Nwaehujor *et al.* (2014) method. The onion bulb was washed with distilled water. The outer covering of the bulbs was manually removed and the fleshy part of the onion was rewashed with distilled water. A blending machine cut 10 g of the onion bulb into small parts and crushed it in 500 ml of water. The mixture was filtered through a muslin cloth and then Whatman no. 1 filter paper. The filtrate was evaporated at 45 ^{0}C to a paste-like gel containing crude quercetin and the paste-like gel substance was kept in a sterile bottle at 4 ^{0}C until required for use.

2.4. Phytochemical screening

The extract was subjected to quantitative analysis of its phytochemical constituents such as Saponins, tannins, reducing sugar, etc).Using standard procedures (Odebiyi and Sofowora, 1978).

2.5. Determination of acute oral toxicity

The acute oral toxicity was determined according to the method described by OECD (2001). Five mature female albino rats were used for the study. Each animal fasted overnight before dosing. One rat was dosed with 5000 mg/kg body weight and observes for 48 hours for

signs of toxicity, including death. After the survival of the 1st, 2nd, 3rd, 4th, and 5th rats were intermittently dosed at 48 hours intervals and observed for signs of toxicity including death. After 48 hours of dosing the last rat, all five rats were observed for two weeks for delayed signs of toxicity, including death after which the rats were sacrificed and buried according to the rules of ethics.

2.6. Animals and experimental design

Forty-eight male albino rats were procured from the Faculty of Basic Medical Sciences animal facilities. They were housed in clean polypropylene cages in a group of six rats per cage, kept in a room maintained at 24-28°C, with controlled light cycles of 12 hours light/12 hours' dark and relative air humidity of 40–60% in the Department of Biochemistry, University of Ibadan. They were acclimatized for seven days before the commencement of the experiment and given standard commercial pellets (Vita Feeds, Ibadan, Nigeria) and water*ad libitum*. The experimental protocol was following the guidelines on the care and well-being of research animals (N.I.H, 1985) and was approved by the Veterinary Faculty Ethics Committee of the University of Ibadan with an assigned number (UI/FVM/22/17). The rats were randomly divided into eight groups of six rats each.Group A: Distilled water (0.2 mL), group B: $KBrO_3$ (30 mg/kg), group C: Quercetin (50 mg/kg), group Dand E: AEAC (200 and 400 mg/kg, respectively), group F: 30 mg/kg $KBrO_3$ with 50 mg/kg quercetin, group G and H: ($KBrO_3$ 30 mg/kg with 200 and 400 mg/kg AEAC, respectively). All treatments were administered via oral gavage on alternate days for 90 days. During this treatment period, the rats were observed for signs of toxicity and death.

2.7. Collection of blood samples

At the end of the experiment (90 days), the rats were fasted overnight and anaesthetized using pentobarbitone sodium (40 mg/kg). Blood samples were collected via the retro-orbital sinus into an EDTA for haematology and another into plain sample bottles and were allowed to coagulate and were then centrifuged at 3000 rpm for 15 min to obtain serum and stored at -4^0C until used for biochemical analysis.

2.8. Haematological analysis

The Hematocrit (HCT), Red Blood Cell (RBC), White Blood Cell (WBC), Hemoglobin Concentration (HGB), Mean Corpuscular Hemoglobin Concentration (MCHC), Mean Corpuscular Volume (MCV), Lymphocyte (LYMPH), were measured using Mindray (BC-5390) Auto Hematology Analyzer.

2.9. Lipid profile analysis

Serum triacylglyceride (TAG), total cholesterol (TC) and high-density lipoprotein cholesterol (HDL-c) concentration were determined using the enzymatic colorimetric method (Bucolo and David, 1973). Calculation of the concentration of low-density lipoprotein cholesterol (LDL-c) in the serum was as previously described by Friedewald *et al.* (1972).

2.10.Calculation of the atherogenic indices

Serum total non-HDL cholesterol (TnHDL-c) concentration was calculated as TC – HDL-c (Castelli *et al.*, 1983), while Cardiac risk ratio (CRR) and Castelli's Risk Index II (CRI-II) were determined as TC/ HDL-c and LDL-c / HDL-c respectively (Badimon *et al.*, 1990; Brehm *et al.*, 2004). Atherogenic index of plasma (AIP) and atherogenic coefficient (AC) levels were calculated as log (TG / HDL-c) and (TC - HDL-c) / HDL-c respectively (Dobiásová,2004; Haneman and Zidenberg-Cherr, 2008).

2.11. Statistical analysis

Data obtained from this study were expressed as mean ± standard error of mean. One-way analysis of variance (ANOVA) was used to access the difference between means followed by Turkey's multiple comparison test. Graph Pad Prism 8.*01* was the statistical package used for the analysis and *p*-values < 0.05 were considered statistically significant for differences in means.

3. Results and discussion

3.1. Phytochemical screening

The result of the quantitative phytochemical composition of *A. cepa* is presented in Table 1. Results obtained showed the presence of phytochemicals such as alkaloids, flavonoids, saponins, tannins, reducing sugar, phenol, resin, volatile oil, and steroids. However,

phlobatannins, glycosides, and anthraquinone were absent.

Table 1. Phytochemical contents of the AEAC.

Test	Status
Saponin	+ + +
Tannins	+ + +
Reducing sugar	+ + +
Phlobatannins	- - -
Glycosides	- - -
Anthraquinone	- - -
Alkaloids	+ + +
Flavonoids	+ + +
Steroids	+ + +
Volatile oils	+ + +
Phenols	+ + +
Resins	+ +

+ = Positive; - = Negative

3.2. Oral toxicity test

The oral acute toxicity test showed no mortality after the oral administration of AEAC at a dose above 5000 mg/kg body weight as prescribed by OECD (2001). There were no toxicity signs observed for the initial period of 48 hours and thereafter for 12 days. The lethal dose of the extract was considered greater than 5000 mg/kg body weight (OECD, 2001).

3.3. Effects of AEAC on haematological parameters of KBrO3 treated rats

Table 2 represents the different haematological parameters that were examined. When comparing the $KBrO_3$-treated group to the control, the levels of RBC, PCV, Hb, MCH, MCV, MCHC, WBC, neutrophils, and lymphocytes were significantly decreased ($P<0.05$). These haematological parameters were, however, significantly ($P<0.05$) increased in dose-dependent in the AEAC/ or quercetin+ $KBrO_3$ groups when compared to the $KBrO_3$ group alone.

Table 2. Effects of aqueous extract of *Allium cepa* bulb and $KBrO_3$ on lipid and atherogenic profile in the experimental rats.

Parameters	TC (mg/dL)	TG (mg/dL)	HDL-c (mg/dL)	LDL-c (mg/dL)	TnHDL-c (mg/dl)	CRR	CRI	AC	AIP
Group A	120.7±4.89	117±0.44	54.14±0.95	44.5±1.12	66.55±0.02	2.23±0.02	2.14±0.11	1.23±0.02	0.34±0.01
Group B	127.9±1.85[a]	127±6.34[a]	47.2±3.16[a]	57.3±0.93[a]	79.70±0.03[a]	2.71±0.13[a]	2.63±0.06[a]	1.65±0.23[a]	0.43±0.03[a]
Group C	120.6±2.41	115±1.35	52.64±1.15	31.62±0.16	67.96±0.12	2.29±0.13	2.29±0.20	1.29±0.14	0.33±0.01
Group D	121.4±6.44	114±1.16	53.43±1.54	37.53±1.24	67.97±0.03	2.27±0.04	2.27±0.08	1.27±0.06	0.33±0.03
Group E	123.5±5.46[b]	116±0.68	57.14±0.95	34.96±0.82	66.36±0.02	2.16±0.07	2.16±0.17	1.16±0.08	0.31±0.01
Group F	124.5±1.43[b]	120±0.68[b]	60.05±0.27[b]	49.08±0.50[b]	64.44±0.11[b]	2.07±0.12[b]	2.02±0.17[b]	1.07±0.01	0.30±0.04[b]
Group G	125.9±2.00[b]	122±2.31[b]	62.33±1.79[b]	48.75±0.62[b]	63.57±0.02[b]	2.02±0.06[b]	2.02±0.08[b]	1.02±0.21	0.29±0.01[b]
Group H	122.9±1.16[b]	120±1.24[b]	57.06±0.57	42.86±0.93[b]	65.84±0.15[b]	2.15±0.11[b]	2.15±0.35[b]	1.15±0.04	0.33±0.02[b]

a= statistically significant when compared with negative control (distilled water only) at $P<0.05$. b= statistically significant when compared with the positive control ($KBrO_3$) at $P<0.05$.

A: Distilled water; B: 30 mg/kg $KBrO_3$; C: 50 mg/kg quercetin; D: 300 mg/kg AEAC; E: 150 mg/kg AEAC; F: $KBrO_3$+ 300 mg/kg AEAC; G: $KBrO_3$+ 150 mg/kg AEAC; H: $KBrO_3$+ quercetin;TC: Total Cholesterol; TG: Triglyceride; HDL-c: High Density Lipoprotein Cholesterol; LDL-c: Low Density Lipoprotein Cholesterol; TnHDL-c: Total Non-HDL-c; CRI-I: Castelli's Risk Index I; CRI-II: Castelli's Risk Index II; AC: Atherogenic Coefficient; AIP: Atherogenic Index of Plasma.

3.4. AEAC beneficially modulates atherogenic profile in KBrO3-treated rats

As shown in Table3, in contrast to the control group, the administration of $KBrO_3$ caused a significant ($P<0.05$) increase in the serum levels of TC, TG, and LDL-C.

Table 3. Haematological parameters of rats administered KBrO3 and treated with AEAC.

Parameters	RBC ($\times 10^{12}L^{-1}$)	PCV (%)	HB (g/dL)	MCH (pg)	MCHC	MCV (pg)	WBC count ($\times 10^9$/L)	Lymp ($\times 10^9$/L)	Mono ($\times 10^9$/L)	Baso ($\times 10^9$/L)	Eosi ($\times 10^9$/L)	Neut ($\times 10^9$/L)
Group A	6.13±0.06	43.24±0.81	13.0±1.08	21.11±0.03	30.03±0.36	70.5±0.61	8.00±0.05	6.20±1.41	6.70±0.30	0.00±0.00	0.00±0.00	0.00±0.00
Group B	4.00±0.09[a]	39.08±0.62[a]	8.0±1.76[a]	20.00±0.31	20.47±1.2[a]	89.1±0.57[a]	5.37±0.33[a]	3.24±1.11[a]	3.60±0.30[a]	0.00±0.00	0.01±0.00	0.00±0.00
Group C	5.80±0.06	47.87±1.49	14.3±0.88	22.90±0.02	29.68±0.25	82.4±0.81	7.02±0.46	5.23±0.86	7.10±0.31	0.00±0.00	0.00±0.00	0.00±0.00
Group D	5.33±0.09	44.03±1.43	13.0±0.41	24.52±0.03	28.61±0.29	82.07±0.81	7.12±0.22	5.54±0.91	7.00±0.30	0.00±0.00	0.00±0.00	0.00±0.00
Group E	5.32±0.12	56.57±3.50	12.7±1.45	23.87±0.04	21.51±0.27	104.3±0,83	7.02±0.52	5.30±1.37	7.30±0.20	0.00±0.00	0.02±0.00	0.00±0.00
Group F	4.24±0.10[b]	41.60±0.63[b]	14.5±1.44[b]	34.20±0.16[b]	36.81±0.51	92.1±0.34[b]	5.30±0.06	3.90±0.67	5.30±1.2[b]	0.00±0.00	0.00±0.00	0.00±0.00
Group G	4.73±0.09[b]	41.05±0.49[b]	13.7±0.88[b]	28.96±0.05[b]	32.47±.034	86.5±0,67[b]	6.72±0.75[b]	4.87±1.53[b]	5.50±1.0[b]	0.00±0.00	0.00±0.00	1.30±0.00
Group H	4.87±0.09[b]	41.26±0.71[b]	13.3±1.65[b]	27.31±0.07[b]	32.23±0.32	84.7±0.76[b]	5.20±0.33	4.90±0.66[b]	5.00±0.4[b]	0.00±0.00	0.00±0.00	1.00±0.00

a= statistically significant when compared with negative control (distilled water only) at $P<0.05$. b= statistically significant when compared with the positive control ($KBrO_3$) at $P<0.05$. A: Distilled water; B: 30 mg/kg $KBrO_3$; C: 50 mg/kg quercetin; D: 300 mg/kg AEAC; E: 150 mg/kg AEAC; F: $KBrO_3$+ 300 mg/kg AEAC; G: $KBrO_3$+ 150 mg/kg AEAC; H: $KBrO_3$+ quercetin; RBC: Red blood cells; PCV: packed cell volume; Hb: Haemoglobin; MCV: Mean corpuscular volume; MCH: Mean corpuscular

haemaglobin; MCHC: Mean corpuscular haemoglobin concentration; WBC: white blood cells; Lymp: lymphocyte; Eos: Eosinophils; Baso: Basophils; Neu: Neutrophils; Mon: Monocytes.

Contrarily, when $KBrO_3$ was administered alone, the level of high-density lipoprotein cholesterol (HDL-C) in the serum was significantly ($P<0.05$) reduced than it was in the control group. In comparison to the $KBrO_3$ group, treatment with $KBrO_3$ and AEAC or quercetin significantly ($P<0.05$) decreased serum levels of TC, TG, and LDL-C and significantly increased HDL-C. The group that received $KBrO_3$ experienced an increase in TnHDL-c, CRI-I: CRI-I, CRI-II, AC, and AIP relative to the control. In contrast, the co-treatment groups experienced ameliorative effects from the extract and quercetin against the $KBrO_3$-induced elevation in the atherogenic indices.

The phytochemical analysis of the AEAC reveals the presence of saponin, tannins, reducing sugars, alkaloids, flavonoids, steroids, volatile oils, phenols, and resin and there was an absence of phlobatannins, anthraquinone, and glycosides. Haliwell (1994) reported the presence of various phytochemicals including alkaloids, flavonoids, saponins, terpenoids, etc. which are a variety of plant-derived compounds responsible for protection against diseases. Phytochemicals have valuable effects such as antioxidants, capable of neutralizing free radicals which are implicated in heart disease, strokes, and cancer (Lipkin, 1995), all of which are complications of high concentration of plasma/tissue lipid, hence, the lipid-lowering actions. Alkaloids are reported by Watson in 2006 to inhibit the accumulation of cholesterol in the vessels and thus are helpful in improving cardiac conditions. The presence of flavonoids in extracts has been known to enhance antihyperlipidaemic activity (Rajani and Purnima, 2009). Saponins are known to bind cholesterol, thus preventing its reabsorption and, increasing its excretion from the body leading to its depletion in the body (Ford *et al.*, 2002), and consequently enhancing the lipid-lowering action of the test extracts.

The result of the oral acute toxicity test for AEAC showed that there was no mortality after its oral administration at a dose above 5000 mg kg^{-1} body weight as prescribed by OECD (2001), and shows that the extract is safe.

Lipids play an essential role in the body, however, are one of the most vulnerable and targeted macromolecules by free radicals, resulting in peroxidation, a condition known to induce a wide range of pathological processes (Lu *et al.*, 2015). Hyperlipidemia and hypercholesterolemia are labeled as the core determinant of lifestyle-related diseases particularly atherosclerosis and associated cardiovascular complications, cerebral paralysis, and myocardial infarction (Ida *et al.*, 2019). Prevention or treatment of such disorders can be achieved through the ingestion of natural products and/or drug administration (Abdel-Latif *et al.*, 2021).

Results of this present study show that prolonged oral administration of $KBrO_3$ resulted in dyslipidemia characterized by elevated plasma triglycerides (TG), total cholesterol (TC), and low-density lipoprotein cholesterol (LDL) concentrations, and decreased plasma high-density lipoprotein cholesterol (HDL) concentrations. This could be a result of hepatotoxicity associated with $KBrO_3$ administration. Dyslipidemia is an incurable but controlled condition and previous studies have shown that controlling blood lipids can efficiently reduce the risk of cardiovascular diseases (Lee *et al.*, 2008). The observed adverse effect of $KBrO_3$ in this study is congruent with the earlier finding by Kim and Yim (2015). Lu *et al.* (2015) in a comparative study on $KBrO_3$ also reported a perturbation in lipid indices analogous to what was observed in this study. The significant elevation in serum LDL levels could result from its suppressed receptor activity (Majewska-Wierzbicka and Czeczot, 2021), accounting for rising VLDL conversion to LDL, ensuing excessive production and accumulation of LDL. LDH is considered ahepatotoxic indicator and the increased LDH level in $KBrO_3$ groups that has been observed in the current study is by previous reports (Ahmad *et al.*, 2014).However, the groups co-treated with $KBrO_3$ and the AEAC/quercetin showed decreased TG, LDL-c, and cholesterol levels with improved levels of HDL-c. The attenuation in serum TC, LDL, and Cholesterol concentration observed in the extracts treated rats may be attributed to an increase in the serum HDL-c concentration (Aletan, 2014). Lately, quite a lot of studies have examined the effects of onion on blood lipids, but the results are opposing. Dhembare and Dale (2017) found that supplementation with onion skin extracts significantly improved TC, LDL, and HDL levels, however, Chipman *et al.* (1998)

reported no significant difference in lipid profile after administration of onion extract compared with control. The groups administered the graded doses of AEAC and quercetin only in the present study showed a level of lipid profile indices parallel to the control group, and this may entail that the extract and quercetin have cardioprotective potential. The functional component in *A. cepa* for averting heart diseases is quercetin (Sai *et al.,* 1992). Quercetin is useful for preventing and treating a variety of cardiovascular diseases by lowering cholesterol levels and boosting antioxidant capacity (Thompson and Westfall, 1948). Atherogenic indices are indicative of a high risk of cardiac-associated disease. The more elevated their values, the greater the risk of developing cardiovascular problems and vice versa. The outcome of this study shows that administration of $KBrO_3$ alone causes a significant ($P<0.05$) increase in the atherogenic values including Castelli's index I and II, atherogenic coefficient, and atherogenic index of plasma in the rats relative to the control group. These indicate the potential risk of cardiovascular disease $KBrO_3$-treated group. Conversely, there was a significant ($P>0.05$) decline in the atherogenic indices in the groups co-treated with the $KBrO_3$ with the AEAC and quercetin. The attenuation in the values of the atherogenic indices observed in the groups co-administered $KBrO_3$ with the AEAC and quercetin show that both the AEAC and quercetin have abrogative effects against KBrO3-induced toxicity and also cardioprotective potentials.

The administration of $KBrO_3$ alone in this present study showed a decrease in all blood parameters (R.B.C.s, WBCs, HB, and PCV) relative to the control. In specific terms, this finding is consistent with the earlier report of other authors, Maaroufi *et al.* (1996); Banerjee and Maulik, (2002). The decrease in RBC indices observed in the present study may be due to the detrimental effects of $KBrO_3$ on the bone marrow as a haematopoietic organ. In previous studies, rats treated with $KBrO_3$ showed bone marrow suppression with selective megacaryocyte depression (Cay and Naziroglu, 1999). Simultaneous treatment of the rats with $KBrO_3$ and AEAC/quercetin improved the RBC values. An increase in the RBC count in the *A.cepa*-treated animals shows the blood-promoting action of the onion bulb extract as revealed by (Jibrin *et al.,* 2006). Onion is also a popular folk remedy, rich in flavonoids such as quercetin and its sulfur compounds have perceived benefits to human health (Jibrin *et al.,* 2006).

In the present study, the MCH and MCHC values of the $KBrO_3$ treated group was significantly lower when compared with the control and the groups administered AEAC and quercetin alone, which suggested that the observed correlation in RBC and Hb, occurred through the rupture of red blood cells (Parsons and Chipman, 2000). MCHC values increased with simultaneous treatment of $KBrO_3$ with AEAC and quercetin.

Since Hb, RBC, and PCV relate to the total population of red blood cells in the blood while MCHC, MCH, and MCV relate to individual red blood cells, it follows that the $KBrO_3$ may have an impact on the incorporation of hemoglobin into red blood cells as well as the morphology and osmotic fragility of red blood cells produced. Additionally, the decrease in Hb, RBC, and PCV indicate that the $KBrO_3$ resulted in a decline in the number of red blood cells made in the bone marrow.

Our findings showed decreased total leukocyte count, lymphocytes, and monocytesin rats administered $KBrO_3$ only and these findings were in agreement with the report of (Akintola *et al.,* 2020). This suggests that $KBrO_3$ could cause destruction or impaired production of white blood cells. But the decrease in the number of leucocytes may be due to D.N.A. strand breakage in these cells caused by oxidative stress associated with potassium bromate administration (Sai *et al.,* 2000; Parson and Chipman, 2000). Furthermore, there could have been bone marrow suppression with selective megakaryocytic depression (Hoffbrand *et al.,* 2004). But in the groups co-administered $KBrO_3$ and EAAC with quercetin, there was a significant increase in the value of the WBC, lymphocytes, and monocytes when compared with the control and the group treated with $KBrO_3$ only. These findings are in agreement with earlier studies, including (Akinola *et al.,* 2020). This effect may indicate an activation of the animal's immune system by the extract and quercetin (Dhembare and Dale, 2017). The fact that $KBrO_3$ administration decreased the WBC, RBC indices, and platelet counts raises the possibility that $KBrO_3$ has the potential to cause progressive bone marrow depression. This is due to the fact that the bone marrow is in charge of producing red blood cells and white blood cells.

4. Conclusion

In the present study, it was observed that $KBrO_3$-induced blood cell alterations were ameliorated in the groups co-treated with AEAC and quercetin and this, therefore, suggests that AEAC together with quercetin has hypolipidemic effect can abrogate chemically induce blood cell damage.In light of the results obtained in this study, the AEAC has demonstrated to posse's lipid-lowering activity as revealed by its antihyperlipidemic and antihypercholesterolaemic against $KBrO_3$- induced toxicity. Furthermore, the extract also shows the potential to abrogate haematological alteration due to $KBrO_3$ administration in rats. The observed therapeuticbenefits herein may explain the widespread use of the *Allium cepa* in ethnotraditional medicinal practice.

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6. References

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