Ethylacetate extract of red onion (Allium cepa L.) tunic affects hemodynamic parameters in rats

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Abstract

The effects of ethylacetate extract of red onion (Allium cepa) tunic (ACTE) on some hemodynamic and biochemical parameters were evaluated in normotensive albino rats. Blood pressure parameters were determined in anaesthetized rats orally administered ACTE (10-, 20-, or 40 mg/kg) or ramipril (1 mg/kg) once daily for 14 days. Respectively, 10-, 20-, or 40 mg/kg ACTE produced significant (P < 0.01), dose-dependent fall in systolic blood pressure, SBP (21%, 27%, 33%), diastolic blood pressure, DBP (6%, 10%, 16%), pulse pressure, PP (42%, 49%, 56%), mean arterial blood pressure, MAPB (13%, 18%, 23%) and heart rate, HR (4%, 5%, 7%). The highest effective dose (40 mg/kg) compared well with ramipril (1 mg/kg) with regards to SBP (41%), DBP (19%), PP (70%), MABP (29%) and HR (10%). Similar trends (decreases) were recorded for 40 mg/kg ACTE and ramipril, respectively, as regards the activities of serum enzymes: creatine kinase (60% and 65%), ALT (18% and 14%) and ALP (28% and 16%). HPLC fingerprints of the flavonoid-rich ACTE revealed that flavonoids: quercetin, quercitrin, isoquercitrin, rutin and kaempferol are the active flavonoids. The results demonstrate the hypotensive effect of A. cepa tunic flavonoids initiating further investigation of their individual or synergistic contribution(s) to the observed effects.

Keywords: Allium cepa; Extract; Flavonoids; Hemodynamic; Hypotension

1. Introduction

Agents with hypotensive effect could be of therapeutic significance in the advent of clinical or experimental-induced hypertension. One quarter of the world’s adult population is afflicted by hypertension, and this is likely to increase to 29% by 2025 [1]. The common progressive disorder leads to several chronic diseases such as cardiovascular disease, stroke, renal disease and diabetes [2].

Plants constitute a rich and diverse source of secondary metabolites that have long contributed to the development of small-molecule based therapeutics [3]. Onion (Allium cepa L.), a bulbous herb belonging to the family Aliiceae, is a widely consumed vegetable. It is a good source of dietary phytochemicals including organosulphur compounds and flavonoids [4]. As a result of their phytoconstituents, onions exhibit considerable antioxidant properties and could modulate the detoxification systems [5]. Thus, onion intake is reported to have several beneficial effects on health, such as preventing tumors and cancers [6], cardiovascular diseases [7] and hypertension [8]. Most of the documented beneficial effects of onions,
including inhibition of platelet aggregation [9], hypoglycaemic, hypolipidemic and antiatherosclerotic [10,11], and antioxidant and antiapoptotic effects [12], have centered on the bulb or other edible parts rather than the tunic which is normally discarded as wastes. We envisaged that this underutilized part of onion, which has not received much attention all the while, may have potential benefits to human health. To the best of our knowledge, there is a dearth of information on effect of red onion (A. cepa) tunic on hemodynamic parameters. This work was therefore initiated to provide scientific information in this regard.

2. Materials and methods

2.1. Chemicals

Glutathione, 5,5′-dithiobis-(2-nitrobenzoate) DTNB, epinephrine and hydrogen peroxide were purchased from Sigma Chem., Co. (London, UK). Alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), creatine kinase (CK), total protein and total cholesterol kits were obtained from Randox Laboratories, UK. All other chemicals were of analytical grade and were either obtained from Sigma–Aldrich or British Drug Houses, (Poole, UK).

2.2. Plant material

Red onions (A. cepa) were bought from Shasha market, out-skirt Akure metropolis, Nigeria, in the month of February 2013. Botanical identification and authentication were carried out at the herbarium of the Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria.

2.3. Preparation of ethylacetate extract of red onions (A. cepa) tunic

The tunics of onions were removed, cleaned, air-dried and pulverized. The powdered sample (80 g) was macerated in 600 mL of ethyl acetate (Sigma Chemicals; USA) for 4 h at 40 °C, with constant agitation. The mixture of the solvent and the ground sample was filtered first with mesh cloth, and then with filter paper (Whatman No. 1) and concentrated using a rotary evaporator. The residue was kept in a refrigerator at 4 °C until further uses. Prior to the experiments, the ethylacetate extract was dissolved in distilled water and diluted to the desired concentrations to give a water-soluble fraction (ACTE).

2.4. Phytochemical screening

ACTE was screened for the presence of alkaloids, saponins, tannins, steroids, anthraquinones, terpenoids, flavonoids and phlobatannins as described in our previous work [13].

2.5. Determination of total flavonoid content

The colorimetric method described by Dewanto et al. [14] was employed in the quantification of total flavonoids in ACTE. To 250 μL of the suitably diluted sample, 75 μL of 5% NaNO2 solution, 150 μL of freshly prepared 10% AlCl3 solution, and 500 μL of 1 mol/L NaOH solution were added. The final volume was adjusted to 2.5 mL with deionized water and the mixture left to stand for 5 min. The absorption was thereafter measured at 510 nm against the same mixture, without the sample, as blank. The amount of total flavonoids was expressed as quercetin equivalents (QE, mg quercetin/g sample) through the calibration curve of quercetin.

2.6. Quantification of flavonoids

Reverse phase chromatographic analyses were carried out under gradient conditions using C18 column (4.6 mm × 150 mm) packed with 5 μm diameter particles; the mobile phase was water containing 2% acetic acid (A) and methanol (B), and the composition gradient was: 5% of B until 2 min and changed to obtain 25%, 40%, 50%, 60%, 70% and 100% B at 10 min, 20 min, 30 min, 40 min, 50 min and 60 min, respectively, following the method described by Peroza et al. [15] with slight modifications. ACTE was analyzed at a concentration of 12 mg/mL. The presence of flavonoids was investigated, namely, quercetin, isoquercitrin, quercitrin, rutin and kaempferol. Identification of these compounds was performed by comparing their retention time and UV absorption spectra with those of commercially available standards and by DAD spectra (300–600 nm). The flow rate was 0.7 mL/min, injection volume 50 μL and the wavelength was 356 nm. The samples and mobile phase were filtered through 0.45 μm membrane filter (Millipore) and then degassed by ultrasonic bath prior to use. Stock solutions of standards references were prepared in the HPLC mobile phase at a concentration range of 0.050–0.500 mg/mL for quercetin, isoquercitrin, quercitrin, kaempferol and rutin. All chromatography operations were carried out at ambient temperature and in triplicate.

The limit of detection (LOD) and limit of quantification (LOQ) were calculated based on the standard deviation of the responses and the slope using three independent analytical curves, as defined by Sabir et al. [16]. LOD and LOQ were calculated as 3.3 and 10 σ/S, respectively, where σ is the standard deviation of the response and S is the slope of the calibration curve.

2.7. Animals

Adult male rats (Wistar strain) weighing 200–220 g, obtained from a private breeder and housed in the primate colony of the Department of Physiology, College of Medicine, University of Lagos, Nigeria were used for this study. The animals were kept in wire mesh cages under controlled light cycle (12 h light/12 h dark), fed with commercial rat chow (Vital Feeds Nigeria Limited) ad libitum, and liberally supplied with water. All animal experiments were conducted according to the guidelines of National Institute of Health (NIH publication 85-23, 1985) for laboratory animal care and use.
2.8. Experimental design

Age-matched male rats were divided into five groups (n = 5) and treated as follows:

**Group I:** control, distilled water (1 mL/kg).
**Group II:** 1 mg/kg ramipril.
**Group III:** 10 mg/kg ACTE.
**Group IV:** 20 mg/kg ACTE.
**Group V:** 40 mg/kg ACTE.

Drugs or distilled water were administered by gavage to normotensive rats once daily for 14 consecutive days. Twenty-four hours after the last administration, animals were anaesthetized with a mixture of urethane (25%) and alpha-chloralose (1%) to determine the hemodynamic parameters. Animals were thereafter sacrificed, blood was collected through cardiac puncture and hearts were excised. Sera and heart homogenates were then prepared for biochemical evaluations.

2.9. Determination of blood pressure

Blood pressure parameters of rats were determined as previously described [17]. At state of anaesthesia, the animal were laid supine and carotid artery exposed and cannulated with a small polyethylene catheter connected to a pressure transducer (Becton Dickinson, Sandy, UT, USA) which in turn was connected to a polygraph 7D model of Grass Polygraph (Grass Instrument Company, Quincy, Massachusetts, USA). The speed of the equipment was 10 mm/s. The blood pressure was then calculated as recorded in form of tracing by the polygraph after a 20-min stabilization period. The body temperature of rats was maintained at 37°C with a heating pad throughout the experiment. On the tracing, the values from the baseline to the lowest border of the tracing represent the diastolic pressure while from the baseline to the upper border represent the systolic pressure. Each centimeter (cm) change on the tracing paper corresponds to 20 mm Hg pressure change in the grass polygraph. The mean arterial blood pressure (MAPB) was calculated as follows: MAPB = DP + 1/3 (SP-DP), where DP = diastolic pressure and SP = systolic pressure. Heart rate (beats/min) corresponds to the number of strokes within a distance of 600 mm (60 cm) on the polygraph recordings.

2.10. Preparation of serum and tissue homogenate

The collected blood was allowed to clot and serum was obtained after centrifugation at 3000 r per minute for 15 min. To prepare the tissue homogenate, excised hearts were rinsed in 1.15% KCl and homogenized in aqueous Tris–HCl buffer (50 mmol/L, pH 7.4). Homogenates were centrifuged at 6000 × g for 20 min at 4°C to obtain the supernatant fractions which were used for analyses.

2.11. Measurement of serum parameters

The activities of alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), creatine kinase and total cholesterol concentration were estimated in the serum using assay kits from Randox Laboratories Ltd., UK according to the instructions of the manufacturer.

2.12. Assessment of antioxidant status

Antioxidant status was determined in the heart homogenates by quantifying the enzymic (superoxide dismutase and catalase) and non-enzymic (reduced glutathione) antioxidants.

2.12.1. Determination of superoxide dismutase (SOD) activity

The activity profile of SOD in the homogenates was determined by the method of Misra and Fridovich [18]. Briefly, an aliquot of the diluted sample was added to 2.5 mL of 0.05 mol/L carbonate buffer (pH 10.2) to equilibrate in the spectrophotometer. The reaction was started by the addition of 0.3 mL of freshly prepared 0.3 mmol/L adrenaline to the mixture which was quickly mixed by inversion. The reference cuvette contained 2.5 mL of buffer, 0.3 mL of substrate (adrenaline) and 0.2 mL of water. The increase in absorbance at 480 nm was monitored every 30 s for 150 s. A unit of SOD activity was given as the amount of SOD necessary to cause 50% inhibition of the oxidation of adrenaline to adrenochrome during 1 min.

2.12.2. Determination of catalase activity

Catalase activity was determined by following the decomposition of H2O2 according to the method of Sinha [19]. An aliquot (1 mL) of properly diluted enzyme preparation was rapidly mixed with an assay mixture containing 4 mL of H2O2 (800 μmol) solution and 5 mL of 0.1 mol/L phosphate buffer (pH 7.0) in a conical flask by a gentle swirling motion. The reaction was run at room temperature. A 1 mL portion of the reaction mixture was withdrawn and blown into 2 mL dichromate/acetic acid reagent at 60 s intervals. The H2O2 content of the withdrawn sample was determined by taking the absorbance at 570 nm. Catalase activity was expressed as μmol H2O2 consumed/min/mg protein.

2.12.3. Estimation of reduced glutathione (GSH) level

Reduced glutathione (GSH) level was assayed by measuring the rate of formation of chromophoric product in a reaction between 5,5-dinitrois-2-nitrobenzoic acid and free sulphhydryl groups (such as GSH) as described by Beutler et al. [20]. Tissue supernatant (1 mL) was precipitated with 5% sulphosalicylic acid (1.5 mL) by gentle mixing and allowed to stand for 5 min before filtering. Thereafter, 0.5 mL of filtrate was added to 2 mL of 0.1 mol/L phosphate buffer (pH 7.4) followed by Ellman’s reagent (0.25 mL). A blank was prepared with 2 mL of buffer, 0.5 mL of diluted precipitating solution (three parts to two parts of distilled water) and 0.25 mL of Ellman’s reagent. The optical density was measured at 412 nm. GSH was proportional to the
absorbance at that wavelength and the estimate was obtained from a GSH standard curve.

2.13. Protein estimation

Protein concentration was determined by the method described by Lowry et al. [21] using bovine serum albumin (BSA) as standard.

2.14. Statistical analysis

All values are expressed as mean ± SD of five animals. Statistical evaluation was done using One Way Analysis of Variance (ANOVA) followed by Duncan Multiple Range Test. The significance level was set at \( P < 0.05 \).

3. Results

3.1. Phytochemical constituents of ACTE

The phytochemical analysis of ACTE gave positive result to flavonoids (425.6 ± 5.92 mg quercetin equivalent/g extract) only, thus indicating the antioxidant phytochemicals are the major constituent of the extract (Table 1).

HPLC fingerprints of the flavonoids in ACTE revealed that rutin \( (t_R = 34.79 \text{ min}; \text{ peak 1}) \), isoquercitrin \( (t_R = 39.13 \text{ min}; \text{ peak 2}) \), quercitrin \( (t_R = 45.13 \text{ min}; \text{ peak 3}) \), quercetin \( (t_R = 50.09 \text{ min}; \text{ peak 4}) \) and kaempferol \( (t_R = 52.68 \text{ min}; \text{ peak 5}) \) (Fig. 1), are the active flavonoids. As shown in Table 2, the concentrations (mg/g) of the flavonols are as follows: rutin \( (94.31 \pm 0.02) \), isoquercitrin \( (120.68 \pm 0.03) \), quercitrin \( (51.27 \pm 0.01) \), quercetin \( (78.54 \pm 0.03) \) and kaempferol \( (20.93 \pm 0.01) \).

3.2. Effect on blood pressure parameters

The effect of ACTE on the hemodynamic parameters of rats treated with the extract for 14 days is depicted in Table 3. The hypotensive effect of the extract was significant \( (P < 0.01/P < 0.001) \) and dose dependent in experimental animals. Respectively, 10-, 20-, and 40 mg/kg caused significant \( (P < 0.05) \) decreases (%) in systolic blood pressure, SBP \( (21, 27, 33) \), diastolic blood pressure, DBP \( (6, 10, 16) \), pulse pressure, PP \( (42, 49, 56) \), mean arterial blood pressure, MABP \( (13, 18, 23) \) and heart rate, HR \( (4, 5, 7) \) when compared with the control. The results suggest that the highest efficacy was recorded for 40 mg/kg ACTE, which compares well with the reference drug, ramipril, on SBP \( (41) \), DBP \( (19) \), PP \( (70) \), MABP \( (29) \) and HR \( (10) \).

3.3. Influence on serum biochemical indices

The effect of ACTE on serum biochemical indices of normotensive rats is depicted in Table 4. Significant decrease \( (P < 0.001) \) in the activity of serum cardiac marker, creatine kinase, was noticeable in experimental rats administered 10- (52%), 20- (58%) and 40 mg/kg (60%) of ACTE or 1 mg/kg ramipril (65%). Serum activity of alanine aminotransferase (ALT) was decreased by treatment with 10-, 20 mg/kg ACTE \( (P < 0.01) \), 40 mg/kg ACTE \( (P < 0.001) \) and 1 mg/kg Ram \( (P < 0.001) \). Similarly, serum activity of aspartate aminotransferase (AST) was decreased by 40 mg/kg \( (P < 0.01) \) and 1 mg/kg Ram \( (P < 0.001) \). Significant \( (P < 0.001) \) lowering of alkaline phosphatase (ALP) activity was observed in rats administered all dosages of ACTE and 1 mg/kg Ram. It could also be observed that 40 mg/kg ACTE produced the highest decreases in the activities of serum ALT (18%) and ALP (28%). Concurrently, serum total cholesterol concentration was reduced

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**Table 1**

<table>
<thead>
<tr>
<th>Phytochemicals</th>
<th>Results</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavonoids</td>
<td>+</td>
<td>425.6 ± 5.92 mg QE/g extract</td>
</tr>
<tr>
<td>Tannins</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Saponins</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Phlobatannins</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Anthraquinones</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Alkaloids</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Steroids</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Terpenoids</td>
<td>−</td>
<td></td>
</tr>
</tbody>
</table>

Key: +: present; −: absent.
QE: quercetin equivalent.

**Table 2**

<table>
<thead>
<tr>
<th>Compounds</th>
<th>ACTE</th>
<th>LOD</th>
<th>LOQ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg/g</td>
<td>%</td>
<td>μg/mL</td>
</tr>
<tr>
<td>Rutin</td>
<td>94.31 ± 0.02</td>
<td>9.53</td>
<td>0.008</td>
</tr>
<tr>
<td>Isoquercitrin</td>
<td>120.68 ± 0.03</td>
<td>12.06</td>
<td>0.019</td>
</tr>
<tr>
<td>Quercitrin</td>
<td>51.27 ± 0.01</td>
<td>5.12</td>
<td>0.023</td>
</tr>
<tr>
<td>Quercetin</td>
<td>78.54 ± 0.03</td>
<td>7.85</td>
<td>0.035</td>
</tr>
<tr>
<td>Kaempferol</td>
<td>20.93 ± 0.01</td>
<td>2.09</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Results are expressed as mean ± standard deviations (SD) of three determinations. LOD: limit of detection; LOQ: limit of quantification.

3.4. Influence on liver function enzymes

The effect of ACTE on liver function enzymes is shown in Table 5. The liver function enzymes were found to be significantly reduced in the 40 mg/kg group in comparison to the control group. The activities of ALT, AST and ALP were significantly decreased in all the groups treated with ACTE compared to the control group. However, the 10 mg/kg group showed a non-significant decrease in the activity of ALT, AST and ALP. The 20 mg/kg group showed a significant decrease in the activity of ALP. The 40 mg/kg group showed a significant decrease in the activity of ALT, AST and ALP. The results suggest that 40 mg/kg ACTE had a significant effect on liver function enzymes.

**Fig. 1** Representative high performance liquid chromatography profile of flavonoids in ethylacetate extract of Allium cepa tunic. Rutin (peak 1), isoquercitrin (peak 2), quercitrin (peak 3), quercetin (peak 4) and kaempferol (peak 5).
by ACTE (10 mg/kg; \( P < 0.01 \) and 20 mg/kg; \( P < 0.001 \)) and ramipril (1 mg/kg; \( P < 0.001 \)).

3.4. Effect on cardiac antioxidant status

Cardiac activities of superoxide dismutase and catalase were respectively increased \( (P < 0.001) \) in rats treated with 10 mg/kg (53% and 56%), 20 mg/kg (83% and 150%) and 40 mg/kg (111% and 197%) dosages of extract. Treatment with 1 mg/kg Ram also resulted in similar effects on cardiac activities of antioxidant enzymes. On the contrary, the level of GSH was reduced in experimental animals treated with all dosages of extract or ramipril (Fig. 2).

4. Discussion

The result of phytochemical screening revealed the overwhelming presence of flavonoids in the ethylacetate extract of A. cepa tunic (ACTE). The finding is in agreement with previous works [22,23] which showed that ethylacetate fractions contain high amount of phenolics/flavonoids, thus initiating their uses as flavonoid-rich sources. Flavonoids have aroused considerable interest recently because of their potential beneficial effects on human health. In line with previous findings on onions [5,24], HPLC screening of flavonoids in ACTE revealed the flavonols: kaempferol, quercetin and quercetin glycosides (isoquercitrin, quercitrin and rutin) as the active flavonoids.

In the present study, we observed marked decreases in the systolic and diastolic pressure, mean arterial blood pressure, pulse rate and heart rate of rats administered ACTE. The hypotensive effect of ACTE could be of therapeutic benefit in the event of clinical or drug-induced elevated blood pressure or hypertension [25] where reduction in blood pressure is highly desirable. The result was comparable to that recorded for the popular angiotensin-converting enzyme (ACE) inhibitor and hypotensive drug, ramipril. It might be impossible to categorically ascertain the mechanism underlying the hypotensive effect of ACTE from the data obtained in this study. It is however known that ACE inhibitors such as ramipril and captopril lower blood pressure and bring about fewer cardiovascular events in high risk populations by binding a zinc molecule at the active site of ACE, thereby slowing down the conversion of angiotensin I to the potent vasoconstrictor, angiotensin II [26]. Quercetin and its glycosides are often the most abundant polyphenolic compounds found in the human diet, and richly found in the peel of onions [4,5,24]. Several beneficial cardiovascular effects have been ascribed to this phytochemical, including antihypertensive effect and ability to improve endothelial function [27,28]. Flavonoids are known to bind metal ions, such as zinc, and there is evidence that quercetin may inhibit ACE activity via this mechanism [29]. Olaleye et al. [30] reported that rutin and quercetin reduced the blood pressure of animals induced with high salt diet. Overstimulation of the renin-angiotensin system (RAS), and by extension ACE, is one means by which high salt concentration induces hypertension [31]. Going by the aforementioned, it is safe to hypothesize that ACTE could exert its hypotensive effect by interfering with ACE through one or more of its constituent flavonoids.

In the present study, ACTE did not adversely affect serum total cholesterol and markers of tissue injury: creatine kinase CK, aspartate aminotransferase AST and alanine

| Table 3 |

Effects of ethylacetate extract of Allium cepa tunic (ACTE) on blood pressure parameters of rats.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>SBP (mm Hg)</th>
<th>DBP (mm Hg)</th>
<th>PP (mm Hg)</th>
<th>MABP (mm Hg)</th>
<th>HR (beats/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>67.60 ± 1.8</td>
<td>38.80 ± 1.3</td>
<td>28.80 ± 1.3</td>
<td>48.40 ± 1.4</td>
<td>399.40 ± 15.3</td>
</tr>
<tr>
<td>ACTE (10 mg/kg)</td>
<td>53.40 ± 1.1***</td>
<td>36.80 ± 0.8**</td>
<td>16.60 ± 1.3***</td>
<td>42.33 ± 0.7***</td>
<td>382.80 ± 12.2***</td>
</tr>
<tr>
<td>ACTE (20 mg/kg)</td>
<td>49.60 ± 0.9***</td>
<td>34.80 ± 0.8***</td>
<td>14.80 ± 0.4***</td>
<td>39.73 ± 0.8***</td>
<td>377.80 ± 12.4***</td>
</tr>
<tr>
<td>ACTE (40 mg/kg)</td>
<td>45.60 ± 1.1***</td>
<td>32.80 ± 0.8***</td>
<td>12.80 ± 1.1***</td>
<td>37.10 ± 0.8***</td>
<td>369.60 ± 16.2***</td>
</tr>
<tr>
<td>Ram (1 mg/kg)</td>
<td>40.20 ± 1.6***</td>
<td>31.60 ± 1.1***</td>
<td>8.60 ± 0.9***</td>
<td>34.47 ± 1.3***</td>
<td>358.80 ± 13.8***</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation \( (n = 5) \). Ram: ramipril; SBP: systolic blood pressure; DBP: diastolic blood pressure; PP: pulse pressure; MABP: mean arterial blood pressure; HR: heart rate.

** \( P < 0.01 \) compared with the normal control group.

*** \( P < 0.001 \) compared with the normal control group.

| Table 4 |

Effects of ethylacetate extract of Allium cepa tunic (ACTE) on serum biochemical indices of rats.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>CK (IU/L)</th>
<th>ALT (IU/L)</th>
<th>AST (IU/L)</th>
<th>ALP (mg/dL)</th>
<th>CHOL (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>42.92 ± 4.7</td>
<td>8.48 ± 0.46</td>
<td>26.67 ± 0.24</td>
<td>82.50 ± 2.33</td>
<td>18.58 ± 1.3</td>
</tr>
<tr>
<td>ACTE (10 mg/kg)</td>
<td>20.64 ± 2.9***</td>
<td>7.88 ± 0.18**</td>
<td>27.07 ± 0.28</td>
<td>74.58 ± 1.81***</td>
<td>16.07 ± 1.3***</td>
</tr>
<tr>
<td>ACTE (20 mg/kg)</td>
<td>18.16 ± 2.3***</td>
<td>7.80 ± 0.14***</td>
<td>26.87 ± 0.38</td>
<td>66.00 ± 2.33***</td>
<td>12.29 ± 1.2***</td>
</tr>
<tr>
<td>ACTE (40 mg/kg)</td>
<td>17.33 ± 1.8***</td>
<td>6.96 ± 0.18***</td>
<td>26.00 ± 0.24**</td>
<td>59.40 ± 2.33***</td>
<td>19.22 ± 1.3</td>
</tr>
<tr>
<td>Ram (1 mg/kg)</td>
<td>14.86 ± 2.3***</td>
<td>7.32 ± 0.18***</td>
<td>25.40 ± 0.43***</td>
<td>68.64 ± 2.76***</td>
<td>13.23 ± 0.86***</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation \( (n = 5) \). Ram: ramipril; CK: creatine kinase; ALT: alanine amino transferase; AST: aspartate amino transferase; ALP: alkaline phosphatase; CHOL: cholesterol.

** \( P < 0.01 \) compared with the normal control group.

*** \( P < 0.001 \) compared with the normal control group.
aminotransferase ALT. Serum CK and AST have been used as indicators of the stage of myocardial injury [13]. The activities of these cellular enzymes present in the blood are directly related to the intactness of the plasma membrane of the cardiac cells. Therefore, the inhibition of the release of these enzymes into the serum by ACTE could be due to the ability of some of the flavonoids present in the extract to maintain cardiac membrane integrity and restrict the leakage of these enzymes [32]. Conversely, the ability of the ACTE to reduce serum cholesterol in treated animals portrays good signal for cardioprotection taken into consideration the role hyperlipidemia plays in the etiology and progression of many cardiovascular diseases [33,34].

Superoxide dismutase (SOD) and catalase are endogenous antioxidant enzymes responsible for the dismutation of superoxide radicals to H₂O₂ and detoxification of H₂O₂ to water, respectively. Coupled with the actions of the master endogenous antioxidant molecule, GSH, these enzymes offer protection against tissue damage [35]. In the present study, we observed an increase in the activities of cardiac SOD and catalase with concomitant decrease in GSH. The observed effect on GSH is a deviation from the well-established antioxidant activity of flavonoids [36]. It is however known that in vivo, some flavonoid metabolites exhibit prooxidative tendencies [37], some of which proceed via concentration-dependent stimulation.

Fig. 2. Effects of ethylacetate extract of Allium cepa tunic (ACTE) on cardiac activities of superoxide dismutase (A) and catalase (B), and level of reduced glutathione (C) in rats. P value: ***<0.001 compared with the normal control group. ACTE: ethylacetate extract of Allium cepa tunic; Ram: ramipril.
of H$_2$O$_2$ production [35,38]. Such prooxidative tendency does not necessarily indicate toxicity in its entirety but could be beneficial and capable of causing overall cytoprotection [35], since levels of some antioxidant defenses and biotransformation enzymes might be elevated due to the mild degree of oxidative stress ensuing [39]. Oxidative metabolites of flavonoid such as quercetin are preferably inactivated by the major intracellular reducing agent GSH, to form two non-reactive products [40]. The reduced level of GSH could thus be due to the modulation of several biological processes by flavonoids [41].

5. Conclusion

The present study demonstrates the hypotensive effect of red onion (A. cepa) tunic which is often discarded as wastes. Further investigation is however in progress, in the case of this study, to ascertain the effect of chronic consumption of ACTE and evaluate the individual or synergetic contribution(s) of its flavonoids to the observed hypotensive effect.

References


