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Effects of *Allium cepa* on Lipid Profile and Cardiac Enzyme Marker in *Wistar* Rats Fed with High-Fat Diet

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ABSTRACT: *Allium cepa* has been reported to contain some phytochemicals that have possible effects on weight reduction and circulating lipids. This experiment is aimed at observing the effect of *A. cepa* on the lipid profile and cardiac enzyme marker of albino *Wistar* rats fed with high-fat diet. Exactly 48 *Wistar* rats were used in this experiment, and were separated into four different groups as A, B, C and D. Each group had 12rats. The groups were given feed with different compositions as: normal rat feed; *A. cepa* supplemented rat feed; high-fat diet and *A. cepa* supplemented high-fat diet respectively. Animal sacrifice was by euthanasia done by cervical dislocation. Cardiac puncture was via a cardiac puncture and drainage of the abdominal aorta was done. Standard methods were used for analysis. Comparisons were made between control and treatment groups. The result showed that the group on high-fat diet had elevated percentage increase in mean body weight during the period of study. This high weight was down-regulated in the group fed with *A. cepa* supplemented high-fat diet. However, the result showed no significant effect of *A. cepa* and the high-fat diet in the lipid profile and creatine kinase status of the *Wistar* rats during the experimental period of four weeks. On the cardiac risk ratio, a ratio greater than 4.5 is considered a high risk for coronary heart disease. The ratio may be decreased by increasing the good cholesterol (HDL-cholesterol) and/or decreasing the bad cholesterol (LDL – cholesterol). Conclusively, *A. cepa* has the tendency of reducing cardiovascular risks in animals.

Keywords: *Allium cepa*, Lipid profile, Cardiac enzyme, High-fat diet

Introduction

Cholesterol is a lipid molecule which can be synthesized by all animal cells. It has several important functions ranging from being a very important component of all animal cell membranes, where it contributes to membrane integrity and fluidity; to being a precursor molecule for some important biomolecules like hormones and bile acids. According to Enig (2000), it also helps in the healing process as well as normal brain function.

When found in large amounts, it can contribute significantly to body weight leading to weight gain. Increase in body weight above a certain level has several clinical implications and attendant health risks, ranging from cardiovascular diseases, diabetes, hypertension, etc. (Drozdz *et al.*, 2021). Apart from the associated health risks, obese individuals would also want to lose weight for beautification purposes. When serum cholesterol level becomes low, the liver synthesizes a significant amount of cholesterol. In addition to the synthetic function, the liver also helps to circulate and esterify cholesterol through the action of the enzyme lecithin cholesterylacyl transferase (LCAT) (Marshall *et al.*, 2020).

Onion (*Allium cepa* L.) belongs to the family Alliaceae genus *Allium* (Griffiths *et al*., 2002). It is one of the most important cool season vegetable crops. It ranks second in the world among all vegetables in economic importance after tomatoes (Griffiths *et al*, 2002; Mallor *et al*., 2011). The history of onion can be traced back to at least 5000 years and known during the 3200 B.C Egyptian dynasty (Ray and Yadav, 2005). It was introduced

into Europe and brought to North America by Spanish settlers. Since ancient times, people consider it as an indispensable part of human diet and is commonly used both by rich and poor people (James *et al.,* 2018). In Nigeria, onion is cultivated in the north and is consumed nationwide. It is consumed in large quantities together with a local delicacy called suya and it is observed that many of those who consume it in large quantities hardly gain weight (Sofowora, 1993).

Allium cepa is used commonly as food and spice for food. The onion, apart from containing carbohydrate and other food components, also contains several other phytochemicals. Dini *et al*. (2008) observed that *A. cepa* in addition to other compounds and phytochemicals also contain certain cysteine derivatives. According to Casuso *et al*. (2014), quercetin is one of the flavonoid phytochemical components of onions. Quercetin has been observed to exhibit antioxidant properties as well as improve the body's antioxidant status (Qi *et al*., 2022). Some S-substituted L-cysteine phytochemical derivatives of onions have been observed to inhibit fatty acid, as well as cholesterol synthesis (Yu-Yan and Lijuan, 2001). Furthermore, Bueno *et al*. (2020) advised that S-methylcysteine, S-ethylcysteine and S-allylcysteine should be used for treatment of obesity because of induced adipose tissue cell death. There appear to be several important phytochemicals in onion, which could have various health benefits, including the promise of weight reduction. This research work seeks to find any effects of *A. cepa* on the lipid profile and cardiac enzyme marker in rats fed with high-fat diet and any possible correlation with weight reduction.

Materials and methods

Animals: All animals in this study were male albino rat of *Wistar* strain, purchased from the Department of Anatomy, University of Benin, Benin City, Nigeria. They were handled with the guidelines for care and use of laboratory animals in biochemical research as promulgated by Artwohl *et al*. (2006). They were housed in cages and allowed to acclimatize under standard laboratory conditions for seven (7) days. During this period, the rats were given access to rat feed and water *ad libitum*. After acclimatization, 48 rats were transferred into metabolic cages. Each rat was distinctively labeled using picric acid. They were kept in well ventilated room at ambient temperature of 28 ± 2 °C under twelve (12) h light/dark cycle, well fed with food and water according to the feed regimen.

Table 1: Grouping/experimental design

Feed	Group A	Group B	Group C	Group D
Standard feed	Administered	Administered	Administered	Administered
Water	Administered	Administered	Administered	Administered
Allium cepa	-	Administered	-	Administered
Cholesterol	-	-	Administered	Administered

Group A: Control; Group B: *Allium cepa;* Group C: Cholesterol; Group D: *Allium cepa* + Cholesterol

Feed composition: The feed regimen was formulated as shown in Table 2. The carbohydrate constituent was processed white corn flour. The protein constituent was processed fish meal, and the lipid component of the feed was obtained from groundnut cake. The final feed was obtained by grinding, thoroughly mixing and then processing into pellets. The pellets were moderately sun dried and stored in accurately labeled bags.

Table 2: Feed regimen

	Composition (%)			
Constituents	Group A	Group B	Group C	Group D
Carbohydrates	70	65	65	60
Proteins	20	20	20	20
Lipids	10	10	10	10
Allium cepa	-	5	-	5
Cholesterol	-	-	5	5
Total	100	100	100	100

Group A: Control; Group B: *Allium cepa;* Group C: Cholesterol; Group D: *Allium cepa* + Cholesterol

Measurement of body weights: The weight of each rat was measured weekly after acclimatization. This was done for a period of four weeks to ascertain the effect of the various feed constituents on their body weights.

Animal sacrifice: Euthanasia was done by cervical dislocation (Carbone *et al.,* 2012) and drainage of the abdominal aorta (Casal *et al.,* 2017).

Blood sample collection for biochemical assays: This was done via cardiac puncture with drainage of the abdominal aorta (Casal, 2017). The needle in the syringe was removed to avoid red cell haemolysis in high flow pressures of blood out of the syringe (WHO, 2011). Collected blood was then drawn into plain containers waiting biochemical assays of appropriate parameters. In not more than 24 hours. Serum (after the blood was allowed to stand for 1 h to coagulate) samples were subsequently obtained following centrifugation of the blood at 2,500 rpm for five minutes. Biochemical parameters were assayed using commercially available test kits, products of either Randox laboratories, UK or QuimicaClinica Applicada, Spain.

Assays/Estimation

Estimation of total cholesterol: Total serum cholesterol was assayed according to the method described by Allain *et al.* (1974), using Randox Laboratories Kit (Cat. No. CH 200) (Li *et al.*, 2019).

Procedure: One ml of a reagent (containing 0.30 mM 4-aminoantipyrine, 6 mM phenol, peroxidase, cholesterol esterase, cholesterol oxidase and 80 mM pipes buffer pH 6.8) was mixed with 10 µL of sample or standard and incubated at 37 °C for 5 min. The absorbance was read at 546 nm against the reagent blank within 60 min. Total cholesterol concentration of the sample was subsequently calculated against a standard.

Calculation: Total cholesterol (mg/d1) = $\frac{\text{Abs sample}}{\text{Abs standard}}$ X Concentration of standard

Estimation of triglyceride: Serum triglycerides was estimated according to the method described by Tietz (1990), using Randox Laboratories Kit (Cat. No. TR 210) (Cemin *et al.*, 2023).

Procedure: Ten (10) µl of the sample or standard was mixed with 1 mL of a working reagent containing (Pipes buffer reagent: 40 mM Pipes buffer pH 7.6, 5.5 mM 4-chlorophenol and 17.5 mM mg^{2+}) and (enzyme reagent: 0.5 mM 4-aminophenazone, 1.0 mM ATP, lipases, glycerol-kinase, glycerol-3-phosphate oxidase and peroxidase). This was incubated at 37 °C for 5 min and the absorbance was read at 546 nm against reagent blank within 60 min. The triglyceride concentration of sample was calculated against a standard.

Calculation: Triglyceride concentration (mg/dl) = $\frac{\text{Abs sample}}{\text{Abs standard}}$ X Concentration of std

Estimation of high-density lipoprotein (HDL)-cholesterol: Serum HDL was estimated according to the method described by Lopes-Virella *et al.*(1977), using Randox Laboratories Kit (Cat. No. CH 203) (Vijayakumar *et al.*, 2018)

Procedure: Precipitant (1.0 m1) prepared from the commercial kit was added to 0.5 m1 of plasma. The content of the tube was well mixed and allowed to stand for 10miniutes at 37 °C. It was centrifuged for 10 min at 4000 r.p.m. to obtain a clear supernatant. The cholesterol content of the supernatant was enzymatically determined.

Calculation: HDL cholesterol concentration (mg/dl) = $\frac{\text{Abs sample}}{\text{Abs standard}}$ X Concentration of Std

Estimation of low-density lipoprotein (LDL)-cholesterol: LDL-cholesterol concentrations of the serum samples were calculated according to the equation of Friedewald *et al.* (1972); (Penson *et al.*, 2018).

Calculation: LDL-Cholesterol (mg/dl) = $\frac{\text{Total cholesterol - Triacylglycerol— HDL-C}}{5}$

Estimation of very low density of lipoprotein (VLDL)-cholesterol: VLDL-Cholesterol concentration can be calculated by using triacyglycerol values in the manner recommended by Friedewald *et al*. (1972) and Penson *et al.* (2018).

Calculation: VLDL-Cholesterol (mg/dl) = $\frac{\text{Triacylglycerol}}{2.238}$ where 2.238 is a constant.

*Determination of serum creatine kinase activity***:** Creatine kinase determination was based on the method described by Klauke *et al*. (1993). The working reagent was prepared by mixing reagents 1 and 2. One milliliter (1.0 m1) of the working reagent was mixed in a cuvette with 5 ml of serum and incubated at 25 °C for 3 min. The initial absorbance was read at 340 nm and the stopwatch started. The absorbance was read at 1 min intervals thereafter for 3 min. The difference between absorbances and the average absorbance differences per minute (AA/min) was calculated.

Calculation: Creatine kinase activity (U/L) = (OD/min.) X 4127

Determination of plasma creatine kinase activity: Creatine kinase determination was based on the recommendations of the International Federation of Clinical Chemistry by Hørder *et al*. (1991). The working reagent was prepared by mixing reagents 1 and 2. One milliliter (1.0 m1) of the working reagent was mixed in a cuvette with 500 m of plasma and incubated at 25 °C for 3 min. The initial absorbance was read at 340 nm and the stopwatch started. The absorbance was read at 1 min intervals thereafter for 3 min. The difference between absorbance and the average absorbance differences per minute (AA/min) was calculated.

Calculation: Creatine kinase activity (U/L) = (OD/min.) X 4127

Statistical analysis: Values were subjected to statistical analysis using automated package SPSS 10. One-way ANOVA plus Duncan's multiple range tests were used to test for significant differences among the means. A p-value <0.05 was considered to be statistically significant.

Results and Discussion

Results of the mean body weight of the rats fed with normal diet at the end of the 4th week of the experiment are shown in Table 3. The mean body weight of the rats fed with normal diet at the end of the 4th week of the experiment was 149.31± 7.33g. *Allium cepa* supplementation of the feed reduced this mean weight to 141.00 ± 2.51 g at the end of the 4th week of the experiment. High fat diet supplementation of the normal feed with extra cholesterol) is seen to increase the mean weight to 152.17 g at the end of the experiment showing that the weight increase is associated with high-fat diet as previous works reported by other authors (Hariri and Thibault, 2010; World Health Organization, 2021). *A. cepa* addition to the feed supplemented with extra cholesterol is seen to mitigate the effect of high-fat diet on cholesterol by reducing the weight increase caused by cholesterol addition from 152.17 g to 140. 70 g.

Table 3: Weekly body weight (g) of *Wistar* rats under various feed regimen.

Groups	Duration (Weeks)				Mean ± S.E.M.
	1	2	3	4	
A	140.43	165.26	157.26	133.80	149.31±7.33[a]
B	134.10	142.27	146.08	141.53	141.00±2.51[a]
C	138.76	141.60	159.10	169.20	152.17±7.24[a]
D	139.00	150.30	130.25	143.25	140.70±4.19[a]

Values represent mean values to two decimal places. [a] Test values down the same column carrying the same superscripts for each parameter do not differ significantly (p>0.05).
Key**:** A: Control, B: Allium, C: Cholesterol, D: Allium + Cholesterol

From Table 4 it can be seen that the percent change in the mean weights (g) of the rats with high fat (cholesterol feeding) was 21.94 while the percent change in the mean weights (g) of the rats with high fat complementation with high fat (*Allium cepa* + cholesterol feeding) was 3.77. This further corroborates the anti-obesity potential of *Allium cepa*. This is made clearer by looking at the average initial weight of the cholesterol-fed rats which was 138.76 and the average final weight of the cholesterol-fed rats which was 169.20, when this is compared with the average initial weight of the *Allium cepa*+Cholerol- fed rats (139.00 and 143.25, respectively). This finding is in support of the finding of Chung *et al*. (2023) who found an anti-obesity effect of onions in terms of preventing further increase in mean body weights in subjects with obesity.

Table 4: Percentage (%) change in mean body weight (g) of *Wistar* rats under various feed regimen within a period of 4 weeks

Groups	Initial weight	Final weight	Change in mean weight	% change in mean weight
A	140.43	133.80	-6.63[a]	-4.74[a]
B	134.10	141.53	7.43	5.54[a]
C	138.76	169.20	30.44[b]	21.94[b]
D	139.00	143.25	4.25	3.77[a]

Values represent mean values to two decimal places. [a-b] Test values down the same column carrying different superscripts for each parameter differ significantly (p<0.05).
Key: A: Control, B: Allium, C: Cholesterol, D: Allium + Cholesterol

In Table 5, the mean initial weight of the liver was 6.02±1.23 g while the mean weight of the liver at the end of the 4 weeks for rat fed on normal diet was 6.07±0.14 g. *A. cepa* reduced this mean weight to 0.53±0.02 g. According to Fabbrini *et al*. (2010) and Mikolasevic *et al*. (2018), increased liver weight causes hepatomegaly, which makes the liver swollen beyond its normal size and suggests a potential underlying problem. Most often, a potential liver disease that may result in inflammation triggering the progression from non-alcoholic fatty liver disease (NAFLD) to severe fibrogenesis and sometimes in hepatocellular carcinoma (HCC) (Del Campo *et al*., 2018).

Table 5: Organ weights (g) of *Wistar* rats after four weeks exposure to various feed regimen

Groups	A	B	C	D
Liver	6.02±0.23[a]	5.67±0.07[a]	6.23±0.22[a]	6.07±0.14[a]
Left Kidney	0.49±0.05[a]	0.44±0.02[a]	0.51±0.04[a]	0.53±0.04[a]
Right Kidney	0.52±0.05[a]	0.45±0.02[a]	0.53±0.03[a]	0.47±0.03[a]
Heart	0.52±0.03[a]	0.50±0.04[a]	0.54±0.04[a]	0.53±0.02[a]

Values represent mean values to two decimal places. [a]Test values on the same row carrying the same superscripts for each parameter do not differ significantly (p>0.05).
Key: A: Control, B: Allium, C: Cholesterol, D: Allium + Cholesterol

In Table 6, the mean left kidney:body ratio of rats was $3.33\pm1.8 \times 10^{-3}$ when the rats were fed high fat (cholesterol) but this ratio was reduced to $3.25\pm 0.07 \times 10^{-3}$when cholesterol feed was complemented with *Allium cepa*. Also, it can be seen that the mean right kidney: body ratio was $3.49 \pm 0.16 \times 10^{-3}$ with high fat (cholesterol) feeding but this was reduced to $3.23 \pm 0.23 \times 10^{-3}$ when the rats were fed cholesterol complemented with *Allium cepa*. Song *et al*. (2016) investigated whether the ratio of remnant kidney volume to body weight (V/W ratio) can impact renal function in donors, claiming that it was the first study analyzing whether the V/W ratio can influence remnant kidney function in living donors. They found that V/W ratios of < 2.0 do not correlate with reduced renal function in donors after kidney donation, but they are associated with higher risk of 24-hour urinary protein levels that exceed the upper normal limit. Csaba *et al*. (2017) investigated obesity and kidney disease and on behalf of the World Kidney Day Steering Committee noting that obesity is a potent risk factor for the development of kidney disease. This, when correlated with the present study, suggests that high fat diet leads to potential heart disease that *Allium cepa* tries to helps to avoid its progression. Csaba *et al*. (2017) stated that the deleterious effect of obesity on the kidneys extends to other complications such as ephrolithiasis and kidney malignancies. In the same Table 6, the mean heart: body weight ratio was $3.67\pm0.29^{a} \times 10^{-3}$ when threats were fed with high fat (cholesterol) but this ratio was reduced to $3.53\pm0.11^{a} \times 10^{-3}$ when cholesterol is complemented with *A. cepa*. Excess weight can lead to fatty material building up in the arteries (Henning, 2021). If the arteries that carry blood to your heart get damaged and clogged, it can lead to a heart attack (Bahit *et al*., 2018). It can be inferred that since *A. cepa* reduces heart:body weight ratio it contributes to cardiovascular health even in obesity.

Table 6: Organ body weight ratio of *Wistar* rats after four weeks exposure to various feed regimen

Groups	A	B	C	D
Liver	$32.85\pm9.85^{a} \times 10^{-3}$	$41.41\pm0.65^{a} \times 10^{-3}$	$40.79\pm1.970^{a} \times 10^{-3}$	$41.41\pm1.6^{a} \times 10^{-3}$
Left Kidney	$3.42\pm0.55^{a} \times 10^{-3}$	$3.59\pm0.64^{a} \times 10^{-3}$	$3.33\pm1.8^{a} \times 10^{-3}$	$3.25\pm0.07^{a} \times 10^{-3}$
Right Kidney	$6.10\pm3.00^{a} \times 10^{-3}$	$3.44\pm0.31^{a} \times 10^{-3}$	$3.49\pm0.16^{a} \times 10^{-3}$	$3.23\pm0.23^{a} \times 10^{-3}$
Heart	$3.62\pm0.38^{a} \times 10^{-3}$	$3.76\pm0.28^{a} \times 10^{-3}$	$3.67\pm0.29^{a} \times 10^{-3}$	$3.53\pm0.11^{a} \times 10^{-3}$

Values represent mean values to two decimal places. [a] Test values the same row carrying the same superscripts for each parameter do not differ significantly ($p>0.05$).
Key: A: Control, B: Allium, C: Cholesterol, D: Allium + Cholesterol

Table 7 shows that rats fed with high fat diet had a serum cholesterol level of 48.79 ± 11.70 mg/dl. *A. cepa* complementation (addition to the high fat diet) reduced the mean serum cholesterol to 40.53 ± 11.22 mg/ dl. This is supported by the work Li *et al*. (2021) who suggested that *A. cepa* extract (ACE) alleviated hyperlipidemia with down regulation of HMGCR (3-hydroxy-3-methylglutaryl coenzyme A reductase) and upregulation of LDLR (Low-density lipoprotein receptor), suggesting that ACE might be a potential option for hyperlipidemia as non-statin lipid-lowering aid. It also reveals that the normal rat feed produced a mean HDL-C level of 16.56±8.45 mg/dl level of in the rats while complementation with *A. cepa* resulted in a mean HDL-C level of 16.56 ± 8.45 mg/dl in the rats while supplementing with *A. cepa* resulted in a mean in a mean HDL-C level. This suggests the elevation of good cholesterol lipoprotein level by *A. cepa* (remembering that HDL- C is good cholesterol while that LDL-C is bad cholesterol. To emphasize this, this Table further shows that while feeding with high fat diet produced an LDL- C level of 52.99±18.54, complementation with *A. cepa* produced an LDL- C cholesterol of 39.77±16.69. Kianian *et al*. (2021) reported that S-alk(en)yl cysteine sulfoxide found in *A. cepa* reduces serum LDL cholesterol and raises HDL cholesterol. In addition, S-methyl cysteine sulfoxide results in hypolipidemia. Dyslipidemia is a single major risk factor for the development of future cardiovascular events, including coronary heart disease, myocardial infarction, stroke and peripheral vascular disease (Pol *et al*., 2018).

Table 7: Lipid profile of *Wistar* rats after four weeks exposure to various feed regimen

Groups	A	B	C	D
Cholesterol (mg/dl)	42.21 ± 8.41^{a}	44.05 ± 15.54^{a}	48.79 ± 11.70^{a}	40.53 ± 11.22^{a}
HDL-C (mg/dl)	16.56 ± 8.45^{a}	20.30 ± 12.73^{a}	20.10 ± 10.85^{a}	15.34 ± 6.17^{a}
LDL-C (mg/dl)	46.01 ± 16.45^{a}	53.47 ± 24.81^{a}	52.99 ± 18.54^{a}	39.77 ± 16.69^{a}
VLDL-C (mg/dl)	31.34 ± 7.51^{a}	24.28 ± 4.74^{a}	35.53 ± 4.25^{a}	36.90 ± 6.31^{a}
TG (mg/dl)	70.14 ± 16.79^{a}	54.34 ± 10.60^{a}	79.52 ± 9.49^{a}	82.39 ± 14.22^{a}
CK (U/L)	45.39 ± 26.32^{a}	22.70 ± 12.21^{a}	24.76 ± 7.35^{a}	15.48 ± 7.42^{a}

Values represent mean values to two decimal places. [a] Test values on the same row carryingthesame superscripts for each parameter do not differ significantly ($p>0.05$).
Key: A = Control; B = *Allium cepa;* C = Cholesterol; D = *Allium cepa*+ Cholesterol
CHOL = Cholesterol; HDL-C = High density lipoprotein cholesterol; LDL-C = Low density lipoprotein cholesterol; VLDL-C = Very low-density lipoprotein cholesterol; TG = Triacylglycerol, CK = Creatinine kinase

Conventional biomarkers for cardiovascular risks correlate with TG/HDL-C and the Castelli Risk Index-Indices (Arca *et al.*, 2007; Ama *et al.*, 2017). The cardiac risk ratio (The total cholesterol/HDL ratio) is an indicator of the potential for developing blockages in the arteries of your heart and a ratio greater than 4.5 is considered a high risk for coronary heart disease. A ratio greater than 4.5 is considered a high risk for coronary heart disease (Lemieux *et al*., 2001). The ratio may be decreased by increasing the good (HDL) cholesterol and/or decreasing the bad (LDL) cholesterol.

Table 8 reveals that the cardiac risk ratio at the end of the 4th week of the experiment for rats fed on normal diet was 2.54. The Castelli risk index-I (CRI-I), also known as cardiac risk ratio (CRR), reflects the formation of coronary plaques with a diagnostic value as good as the determination of total cholesterol. This risk for the group of rats fed high fat diet was 4.7 while rats fed on *A. cepa* complemented high fat diet had a CRR of 2.22. This ratio is likely to increase for the high fat diet as with time. But the fact that Allium reduced this risk from 4.7 to 2.22 shows that *A. cepa* reduces CRR and this suggests what will happen if the time frame this experiment was increases to say, three (3) months. The difficulty in handling rats for chronic studies made us stop at 4 weeks. A repeat of this experiment to be on chronic bases will be attempted next time. Creatinine kinase level is used to help diagnose a heart attack (Oudman *et al*., 2014).

Table 8: Cardiac risk ratio (CRR) of *Wistar* rats after four weeks exposure to various feed regimen

Groups	**A**	**B**	**C**	**D**
Castellis Risk Index I (CRI-I)	2.22±0.99	2.17±0.00	2.43±1.08	2.64±1.82
Castellis Risk Index II (CRI-II)	2.78±1.95	2.63±1.95	2.64±1.71	2.59±2.70
Castellis Risk Index III (CRI-III)	4.24±1.99	2.68±0.83	3.96±0.86	5.44±2.31
Atherogenic coefficient	1.55±0.01	1.17±0.22	1.43±0.08	1.64±0.82
Atherogenic Index of serum	0.627	0.428	0.598	0.736

Key: A: Control, B: Allium, C: Cholesterol, D: Allium + Cholesterol

Creatine kinase (CK) increases in adults with uncontrolled hypertension (Luman and Lubus, 2014). CK testing used to be a common test for heart attacks and heart damage. Creatine kinase rapidly provides adenosine triphosphate to highly energy-demanding processes, including cardiovascular contraction, and antagonizes nitric oxide–mediated functions (Brewster, 2018). Tissue creatine kinase activity is reported to be high in black people, a population subgroup with greater hypertension risk (Brewster *et al*., 2012). From Table 8 the mean creatinine kinase values for the various classes of rats viz: 45.39±26.32 for rats fed with normal diet, 22.70±12.21 for rats feed supplemented with *A. cepa*, 24.76±7.35 for rats fed on high fat diet, 15.48±7.42 for rats fed on *A. cepa* complemented diet. It is thus very clear that *A. cepa* reduces creatine values level of rats fed on normal diet and *A. cepa* reduces the decreases the high creatine kinase level associated with high fat diet. Relatively high activity of the enzyme, particularly in resistance arteries, is thought to enhance pressor responses and increase blood pressure (Brewster *et al*., 2006).

Castelli's index (Atherogenic cardiovascular risk assessment) is important in the management of dyslipidaemia (Olamoyegun, *et al*., 2016). Atherogenic Index of Plasma (AIP) and Atherogenic coefficient (AC) are becoming useful indices as risk predictors for cardiovascular disease (CVD) (Adedokun *et al*., 2017). Castelli's Risk Index I (CRI-I) is calculated by the formula: CRI- I= TC/HDL. Castelli's Risk Index II (CRI-II) was calculated by the formula: CRI-II = LDL/HDL (amount of bad cholesterol/good cholesterol). As can be seen from Table 8, the ratio of bad cholesterol/good cholesterol at the end of the 4th week of the study was 2.64±1.71 for rats fed with high fat diet. Complementation with *A. cepa* reduced this risk to 2.59±2.70. Again, *A. cepa* reduced cardiac Castelli risk factor II. In the current experiment, the Catelli risk index II for rats fed with high fat diet was at the end of the 4th week, 2.64±1.71 and *A. cepa* complementation reduced this index to 2.59±2.70.

Atherogenicity index (coefficient) reflects the ratio of atherogenic lipoproteins (LDL) to the content of anti-atherogenic lipoproteins (HDL) in the blood plasma, or more accurately reflects the favorable and unfavorable combination of lipoproteins in terms of the risk of coronary artery disease. The atherogenic index of plasma (AIP) is composed of triglycerides and high-density lipoprotein cholesterol and is a novel marker for assessing the risk of atherogenicity and cardiometabolic health. Atherogenic index of plasma (AIP) has been reported to be associated with cardiovascular diseases. However, no study has yet systematically evaluated the association between AIP and obesity and its advantage in obesity prediction compared with conventional lipid components (Kim *et al*., 2022). The atherogenic index of plasma (AIP) is an unconventional lipid ratio representing the logarithm of the molar ratio of TGs to HDL-C. Accumulated evidence showed that AIP is an important predictive index with a positive correlation with CVD.

$$AIP = log(TG/HDL\text{-}C)$$ (Nwagha and Igweh, 2005; Mudhaffar, 2013).

It has been suggested that an AIP value of under 0.11 is associated with low risk of CVD; the values between 0.11 to 0.21 and upper than 0.21 are associated with intermediate and increased risks, respectively (Dobiasova *et*

al., 2011). From Table 8, the mean antherogenic index of plasma for rats fed with normal diet diet is 0.627, 0.428 for normal feed complemented with *A. cepa*, 0.598 high fat diet, 0.736 high fat complemented with *A. cepa*. Atherogenic index of plasma (AIP) is a novel index composed of triglycerides and high-density lipoprotein cholesterol (Dobiasova and Frohlich, 2001). It has been used to quantify blood lipid levels and commonly used as optimal indicator of dyslipidemia and associated diseases cardiovascular diseases (Bora *et al*., 2017; Yang *et al.,* 2017). This suggests that *A. cepa* reduces the risk of dyslipidaemia of normal diet as it.

Conclusion

This study has revealed the anti-obesity potential of *Allium cepa* and has also shown its ability to prevent hepatomegaly and protect against decreases emanating from high creatine kinase level associated with high fat diet. This study thus suggests that *A. cepa* reduces the dyslipideamic risk associated with high fat diet.

Conflict of Interest

The authors declare no conflicts of interest. The authors alone are responsible for the content and the writing of the paper.

Authors' Contributions

The entire study procedure was conducted with the involvement of all writers.

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