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## A STUDY OF THE HYPOLIPIDEMIC AND ANTIOXIDANT ACTIVITIES OF *BAMBUSA BALCOOA* IN EXPERIMENTALLY INDUCED HYPERLIPIDEMIA IN RABBITS

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### Keywords:

*Bambusa balcooa*, Cardiovascular disease, Hypolipidemic, Antioxidant

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**ABSTRACT: Objective:** The study was carried out to investigate the possible hypolipidemic and antioxidant properties of the shoot extract of *Bambusa balcooa* in experimentally induced hyperlipidemia in rabbits. **Methods:** Ethanolic extract of shoot of *Bambusa balcooa* (EELBB) was evaluated for hypolipidemic and antioxidant activities using 400 mg/kg body weight per day in a high fat diet induced hyperlipidemia in rabbits. The results were analyzed using one-way analysis of variance (ANOVA) followed by Bonferroni's multiple comparison tests and compared to the normal control, experimental control and the standard drug (atorvastatin 2.1 mg/kg body weight per day) groups. The results were expressed as mean±standard deviation (SD). Values with  $p < 0.05$  were considered significant. **Results:** Oral administration of EELBB resulted in decrease in Total Cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C) and a significant increase in the high-density lipoprotein cholesterol (HDL-C) when compared to the experimental control group. There were also significantly elevated catalase and superoxide dismutase (SOD) activities and significantly lower malondialdehyde (MDA) levels in the test group compared to the experimental group. Similar results were also found in the standard drug group. **Conclusion:** The results of our experiment demonstrated that *Bambusa balcooa* possesses significant antihyperlipidemic and antioxidant activities. Hence it could be a more affordable and accessible potential alternative or complement existing anti hyperlipidemic drugs, ameliorating side effects and increasing efficacy.

**INTRODUCTION:** Cardiovascular diseases (CVD) are the leading cause of death and disability in the world<sup>1</sup>. The results of Global Burden of Disease study state age-standardized CVD death rate of 272 per 100000 population in India which is much higher than that of global average of 235. CVDs strike Indians a decade earlier than the western population<sup>2</sup>.

Cardiovascular diseases (CVDs) largely driven by atherosclerotic processes in which dyslipidemia is a central, modifiable risk factor. The global burden of CVD and the causal link between raised blood lipids and atherosclerosis underscore the ongoing need for effective strategies to prevent and treat dyslipidemia<sup>3</sup>.

A variety of cardiovascular diseases have been shown to be associated, at least partially, with an excess production of reactive oxygen species (ROS)<sup>4, 5</sup>. ROS constitute both oxygen free radicals, such as superoxide, hydroxyl radicals, and peroxy radicals, as well as non-radicals, such as hydrogen peroxide, hypochlorous acid, and ozone<sup>6</sup>. ROS also contribute to vascular dysfunction and



remodeling through oxidative damages in endothelial cells. In addition, evidence indicates that LDL oxidation is essential for atherogenesis. Thus, agents with antioxidant activity may prove to be beneficial in treating cardiovascular diseases. Antioxidants, as the name implies, are substances, which counter the effect of oxidants.

Pharmacological lipid-lowering agents such as statins, ezetimibe, fibrates and newer agents (PCSK9 inhibitors, bempedoic acid, etc.) have substantially lowered cardiovascular risk in clinical trials; however, long-term use can be associated with adverse effects or cost and accessibility barriers in some settings<sup>7</sup>. These limitations have stimulated interest in complementary or alternative therapies derived from dietary or botanical sources that may provide hypolipidemic benefits with favorable safety and acceptability profiles. Concurrently, accumulating evidence indicates that antioxidant and anti-inflammatory mechanisms can modulate lipid oxidation and vascular injury, suggesting that agents combining lipid-lowering and antioxidant properties may offer added therapeutic value<sup>8</sup>.

Bamboo (subfamily Bambusoideae) is widely used across Asia both as a food source and in traditional medicine, and its leaves, shoots and other tissues are now recognized as rich sources of bioactive phytochemicals including polyphenols, flavonoids, phytosterols and polysaccharides. Several comparative phytochemical and bioactivity studies published in recent years report high total phenolic and flavonoid contents and robust *in-vitro* antioxidant activity across diverse bamboo species, supporting the rationale for investigating bamboo extracts for metabolic benefits<sup>9, 10</sup>. Recent animal and *in vitro* studies have demonstrated that bamboo leaf extracts can enhance endogenous antioxidant defenses and reduce markers of lipid peroxidation, while bamboo shoot components and related preparations have shown hypolipidemic and anti-obesity effects in diet-induced models<sup>11, 12, 13</sup>. Rabbits are a well-established and physiologically relevant model for experimentally induced hyperlipidemia and atherosclerosis due to their susceptibility to dietary cholesterol and the similarity of lesion development to human atherogenesis. Given this background, an appropriately designed rabbit study can provide

mechanistic and translationally informative data on the therapeutic potential of botanical extracts<sup>14</sup>. Accordingly, the present study was undertaken to evaluate the hypolipidemic and antioxidant activities of *Bambusa balcooa* shoot extract in experimentally induced hyperlipidemia in rabbits. Primary objectives were to quantify the effects of the extract on serum lipid parameters (total cholesterol, LDL-C, high-density lipoprotein cholesterol [HDL-C], triglycerides), assess systemic oxidative stress and antioxidant enzyme responses. We hypothesized that *B. balcooa* extract would ameliorate diet-induced dyslipidemia and reduce oxidative damage *via* bioactive polyphenols and related constituents, thereby supporting further development of bamboo-derived preparations as complementary agents in dyslipidemia management.

**MATERIALS AND METHODS:** The study was conducted in the Department of Pharmacology, Assam Medical College and Hospital, Dibrugarh, during the period from 1<sup>st</sup> July 2024 to 31<sup>st</sup> May 2025 as a prospective interventional animal experiment.

Drugs used in the study included ethanolic extract of shoots of *Bambusa balcooa*. (EEBBS), Atorvastatin was obtained from Lupin LTD., Kartholi, Jammu and distilled water was used as the vehicle. HDL-Cholesterol, Total Cholesterol and Triglyceride were estimated by kit method obtained from Crest Biosystems, Goa, India in a photoelectric colorimeter. Serum catalase levels were assayed by enzymatic method using a spectrophotometer<sup>15</sup>. SOD was assayed according to the method of Kakkar *et al.*<sup>16</sup> Estimation of serum malondialdehyde (mda) using colorimeter (Thiobarbituric acid {TBA} method)<sup>17</sup>. Atherogenic index of plasma (AIP) was calculated using the formula:  $\log(\text{TG}/\text{HDL-C})$ , with TG and HDL-C expressed in molar concentrations.

Potassium Phosphate Buffer, Hydrogen Peroxide Solution and Tricarboxylic acid were obtained from Sigma Private Limited, Bangalore, India. Thiobarbituric acid was obtained from HiMedia Laboratories Private Limited, Mumbai, India.

Standard animal diet consisting of Bengal gram, wheat, maize, and carrot in sufficient quantity and

water *ad libitum* was prepared. A high fat diet consisting of a mixture of coconut oil (from Marico Industries Ltd., Mumbai) and vanaspati ghee (from Ruchi Industries, Mumbai) in a ratio of 2: 3 (v/v) at a dose of 10 ml/kg body weight per day was also prepared<sup>18</sup>. Coconut oil and ghee reliably induced hyperlipidemia in rabbits<sup>19</sup>.

*Bambusa balcooa* plants were collected from areas in and around Dibrugarh, Assam. The plant was identified by Prof. L. R. Saikia of Department of Life Sciences, Dibrugarh University. Specimen of the plant bearing voucher number DU L. Sc 437 was preserved in the herbarium of Dibrugarh University. The shoots of *Bambusa balcooa* were dried and powdered in electrical mixture grinder. 1000 grams of powder was soaked in 90% ethanol and allowed to stand for 15 minutes in an air tight container. The entire solution was then transferred to a percolator and enough of 90% ethanol was added to saturate the powder and leave a stratum above it. The top of the percolator was closed and when the liquid was about to drip from the apparatus, the lower orifice of the percolator was also closed and the solution was allowed to macerate for 72 hours. Then, percolation was allowed to proceed slowly with sufficient solvent at a rate not exceeding 1 ml/min until the percolation stopped by itself<sup>20</sup>. This procedure was repeated twice after full percolation by adding fresh solvent to the previously used drug powder. The extract obtained from percolation was collected in a flask. The extract was flask evaporated by using controlled temperature (bath temperature 40-50°C) until the solvent part was evaporated<sup>21</sup>.

The extract was collected in glass petri dishes, further dried in a vacuum dessicator and finally stored in airtight glass containers in a refrigerator at 2-8°C for use in the experiments. A final yield of 152.7g *i.e.* 15.27% w/w with respect to the original air dried powder was obtained.

Healthy New Zealand white rabbit (*Oryctolagus cuniculus*) of either sex weighing 1.5-2.5kg were taken and approval was taken from Institutional Animal Ethical Committee (IAEC) of Department of Pharmaceutical Sciences, Dibrugarh University, Dibrugarh, Assam (Reg. No.: 1576/GO/a/11/CPCSEA dated 17/02/2012) vide approval number IAEC/DU/71. They were kept

under standard housing conditions in standard cages and maintained under normal room temperature on the standard animal diet consisting of bengal gram, wheat, maize, and carrot in sufficient quantity and water was provided *ad libitum* during the entire period of the experiment. A standard 12-hour light and 12 hour dark (12L:12D) cycle was followed with environmental enrichment mimicking their natural behaviour.

**Phytochemical Screening of EEBBS:** EEBBS was subjected to qualitative phytochemical analysis for alkaloids, flavonoids, tannins, saponins, diterpenes, triterpenes and phenols as per the standard methods<sup>22</sup>.

Acute oral toxicity test for the ethanolic extract of shoot of *Bambusa balcooa* was carried out as per OECD Guidelines 425<sup>23</sup>. No sign of toxicity and mortality was recorded among the rats for EEBBS at the dose of 2000mg/kg. A single dose of EEBBS [2000 mg/kg body weight (b.w)] dissolved in normal saline of 2 ml/100g b.w was administered orally with the help of a feeding tube. Observations were done daily for changes in skin and fur, eyes and mucus membrane (nasal), respiratory signs, circulatory signs, autonomic effects (salivation, lacrimation, perspiration, piloerection, urinary incontinence and defecation) and central nervous system changes (ptosis, drowsiness, tremors and convulsion). No sign of toxicity and mortality was recorded among the rats for EEBBS at the dose of 2000mg/kg. The dose for the experiment was taken as extract weight of 400mg/kg based on the toxicity report and prior literature<sup>24</sup>.

**Method of Preparation of Atorvastatin Suspension:** The stock solution was prepared by mixing 2.1 mg of atorvastatin powder in 5 ml of normal saline to get a suspension of 0.42 mg atorvastatin in 1 ml of that suspension. The daily dose of atorvastatin (2.1 mg/kg/day) for rabbit was calculated by extrapolation from the human dose (80 mg/day) as described by Ghosh MN<sup>25</sup>.

**Method of Inducing Hyperlipidaemia in Rabbits:** Rabbits are susceptible to hypercholesterolemia after excessive cholesterol feeding<sup>26</sup>. The experiment was carried out for a period of 12 weeks. For this purpose, 20 healthy rabbits of either sex were taken from the Central

Animal House of Assam Medical College & Hospital, Dibrugarh. Before starting the experiment, the animals were allowed to acclimatize to the laboratory environment for one week and were provided with standard diet and water in sufficient quantity, as per CPCSEA guidelines. For the experiment, the animals were weighed, recorded, numbered and randomly divided into four groups of 5 animals each using a random number table and treated as follows:

**Group-A: Normal Control:** Received normal diet.

**Group-B: Experimental Control:** received high fat diet at a dose of 10 ml/kg body weight per day mixed with normal diet.

**Group-C: Test Drug:** Received high fat diet mixed with normal diet plus ethanolic extract of shoot of *Bambusa balcooa*. (EEBBS) at a dose of 400 mg/kg/day orally.

**Group-D: Standard Drug:** received high fat diet mixed with normal diet plus Atorvastatin at a dose of 2.1 mg/kg/day per orally. All the animals used for the experiment were kept under observation for daily food intake. The drugs were administered to the animals in the doses given above orally, once daily, for 12 weeks by means of intragastric feeding tube in the volume of 5ml/kg body weight. At the end of the 12 weeks, body weights of all the animals were measured and they were kept fasting for 12 hours.

#### Collection of Blood and Separation of Serum:

Under all aseptic conditions, blood samples were collected from the animals. 5ml blood was taken from each animal via marginal ear vein and collected in separate plain vials where they were kept for some time<sup>27</sup>. Serum from the blood after clotting was separated out and collected in clean centrifuge tube and centrifuged for 5 minutes at 3000 rpm. Atherogenic index of plasma (AIP): log (TG/ HDL-C), with TG and HDL-C expressed in molar concentrations.

**Weight Observation:** The body weight of the animals was recorded by using a standard electronic weight machine (Precision Electronic Instrument's Company, Goldtech measuring scale). Proper care was taken not to hurt the animals during handling. Body weights of all the animals

were recorded at the beginning and at the end of the 12<sup>th</sup> week of the experiment<sup>28</sup>. Comparison was made between the two readings and for individual groups and also among different groups.

**Statistical Analysis:** The results of serum lipid profile and oxidative parameters were statistically analyzed using One-way ANOVA followed by Bonferroni's multiple comparison test. The changes in body weights of different groups were analyzed using One-way ANOVA followed by Bonferroni's multiple comparison test, and initial and final body weights were analyzed using paired t-test. The statistical analysis was done using computerized Graph Pad Prism Software version 5.00. Values with  $p < 0.05$  were considered significant.

**Results and Observations:** The results obtained from the study have been summarized in tables numbered 1 to 4 and the observations are plotted in bar diagrams/pie charts in figures numbered 1 to 4. The values obtained from the study were expressed in specific units, ie, lipid levels in mg/dl, catalase activity in  $\mu\text{mol}/\text{min}/\text{ml}$ , superoxide dismutase (SOD) activity in  $\text{u}/\text{mg}$  protein, malondialdehyde (MDA) level in  $\text{nmol}/\text{ml}$  and body weight was expressed in grams as mentioned in the respective tables. Results of estimations were reported as Mean  $\pm$  SD (standard deviation) of 5 animals at a time from each group. The statistical significance between groups was analyzed separately using One-way analysis of variance (ANOVA), followed by Bonferroni's multiple comparison test and paired t-test wherever required. The significance was expressed by ' $p$ ' values, as mentioned in the tables. ' $p$ ' values of  $<0.05$  were considered as significant. The phytochemical screening of EEBBS revealed the results as shown in the **Table 1**.

**TABLE 1: PHYTOCHEMICAL SCREENING OF EEBBS**

Constituent	Present/Absent
Alkaloids	Present
Flavonoids	Present
Tannins	Present
Saponins	Absent
Diterpenes	Absent
Phytosterols	Present
Phenols	Present

**Acute Toxicity Test of EEBBS:** No mortality was recorded among the rats at the maximum dose of 2000mg/kg (all 5 animals survived at 2000mg/kg).

Hence, the LD<sub>50</sub> can be said to be above 2000mg/kg. Two-tenth (400mg) of this maximum dose tested was selected for the experiments.

**Effect of EEBBS on Serum Lipid Profile in Rabbits FED with High Fat Diet: Table 2 and**

**Fig. 1** show mean serum levels (in mg/dl) of lipid parameters *i.e.* serum total cholesterol, serum triglyceride, serum HDL cholesterol and serum LDL cholesterol, in different groups at the end of 12 weeks of drug administration.

**TABLE 2: EFFECT OF EEBBS ON SERUM LIPIDS AT THE END OF THE 12TH WEEK OF EXPERIMENT**

Groups	Lipid Profile (mg/dl)				AIP (in ratio)
	Serum Total Cholesterol (mg/dl)	Serum Triglycerides (mg/dl)	Serum High Density Lipoproteins (mg/dl)	Serum Low Density Lipoproteins (mg/dl)	
Normal Control	43.29 ± 4.059	60.58 ± 7.367	25.53 ± 1.736	13.55 ± 1.992	0.0514 ± 0.013
Experimental Control	108.9 ± 7.894 <sup>a</sup>	176.7 ± 12.77 <sup>a</sup>	12.48 ± 2.225 <sup>a</sup>	58.14 ± 9.455 <sup>a</sup>	0.7942 ± 0.0468 <sup>a</sup>
Test Drug	73.02 ± 5.675 <sup>b</sup>	109.1 ± 8.75 <sup>b</sup>	27.56 ± 2.907 <sup>b</sup>	26.99 ± 3.169 <sup>b</sup>	0.2363 ± 0.048
Standard Drug	67.93 ± 3.568 <sup>b</sup>	106.8 ± 10.06 <sup>b</sup>	30.71 ± 2.201 <sup>b</sup>	22.43 ± 3.683 <sup>b</sup>	0.1786 ± 0.0261 <sup>b</sup>
F ANOVA df p	118.2 3, 16 <0.05	115.8 3, 16 <0.05	60.41 3, 16 <0.05	60.3 3, 16 <0.05	

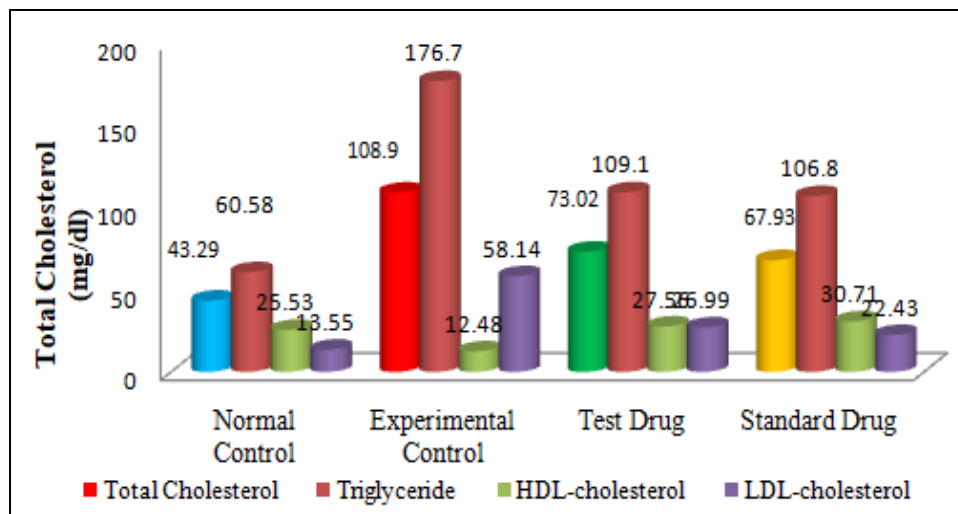
Values are expressed as MEAN ± SD (n=5). One Way ANOVA followed by Bonferroni's Multiple Comparison test is done. <sup>a</sup>p<0.05, when compared to the Normal control Group. <sup>b</sup>p<0.05, when compared to the Experimental Control Group.

The percentage of reduction of serum cholesterol in Test drug group and Standard drug group was 32.94% and 37.62% respectively as compared to Experimental control group.

high density lipoprotein (HDL) cholesterol in Test drug group and Standard drug group was 120.83% and 146.07% respectively as compared to Experimental control group.

The percentage of reduction of serum triglyceride in Test drug group and Standard drug group was 38.25% and 39.55% as compared to Experimental control group. The percentage of increase of serum

The percentage of reduction of serum low density lipoprotein (LDL) cholesterol in Test drug group and Standard drug group was 53.57% and 61.42% respectively as compared to Experimental control.



**FIG. 1: EFFECT OF EEBBS ON TOTAL CHOLESTEROL, SERUM TRIGLYCERIDE, HDL-CHOLESTEROL AND LDL-CHOLESTEROL**

**Atherogenic Index of Plasma (AIP):** The percentage of reduction of AIP in Test drug group and Standard drug group was 71.15% and 77.51%

respectively as compared to Experimental control. **Fig. 2** shows the effect of EEBBS on AIP.

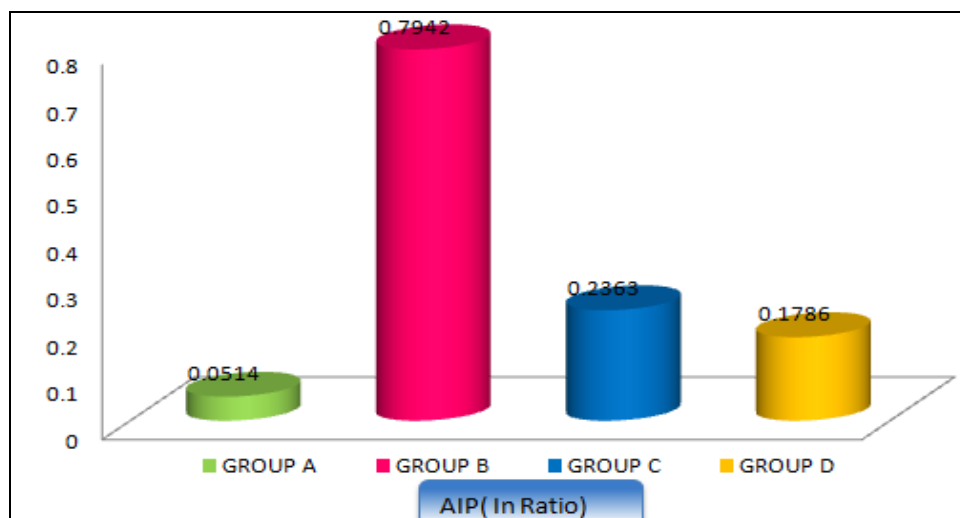


FIG. 2: EFFECT OF EEBS ON AIP

**Effect of EEBS on Catalase Activity in Rabbits FED with High Fat Diet:** The percentage of increase in catalase activity in the Test drug group and Standard drug group was 59.58% and 28.19% respectively as compared to the Experimental control group.

The percentage of increase in SOD activity in the Test drug group and Standard drug group was 53.55% and 49.07% respectively as compared to the Experimental control group. **Fig. 3** and **Table 3** shows the effect of EEBS on catalase activity.

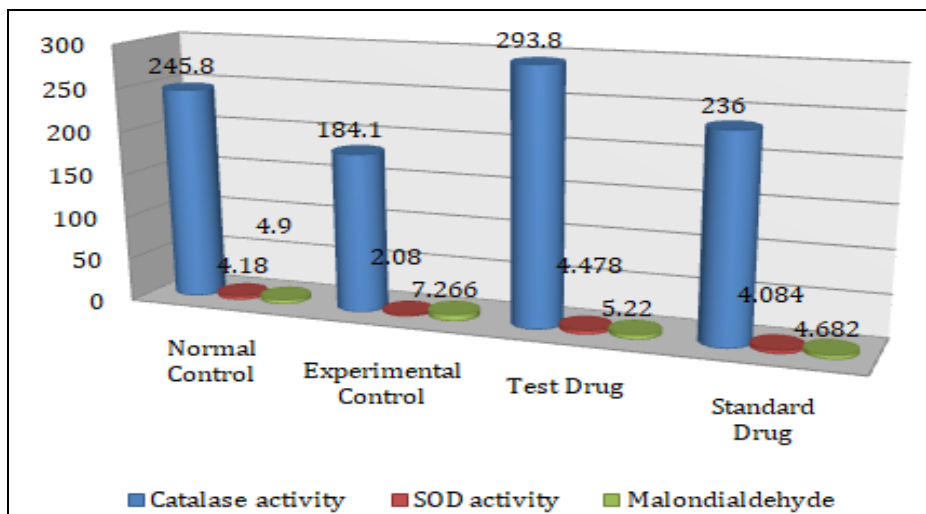


FIG. 3: EFFECT OF EEBS ON CATALASE ACTIVITY

TABLE 3: EFFECT OF EEBS ON CATALASE AT THE END OF 12<sup>TH</sup> WEEK OF EXPERIMENT

Groups	Catalase (µmol/min/ml)	SOD (u/mg protein)	Malondialdehyde (nmol/ml)
Normal Control	245.8 ± 8.228	4.180 ± 0.1095	4.900 ± 0.2807
Experimental Control	184.1 ± 6.507	2.080 ± 0.0837	7.266 ± 0.2506
Test Drug	293.8 ± 6.461	4.758 ± 0.1487	5.22 ± 0.4830
Standard Drug	236.0 ± 6.773	4.284 ± 0.1621	4.682 ± 0.3928
ANOVA	F	203.9	161.6
	df	3,16	3,16
	p	<0.05	<0.05

Values are expressed as MEAN ± SD (n=5). One Way ANOVA followed by Bonferroni’s Multiple Comparison test was done.

**Effect of EEBS on Weight in Rabbits FED with High Fat Diet:** The differences in their baseline body weights were found to be non significant (p>0.05). The final body weight after 12

weeks of treatment showed significant increase in experimental control (16.67%) and test drug group (9.72%) (p<0.05), but the increase in normal (1.55%) and standard drug groups (2.99%) were

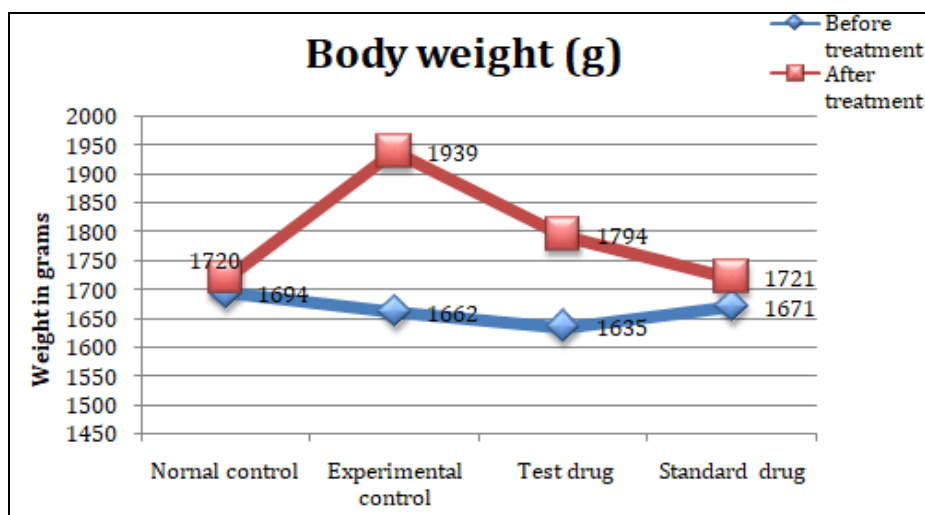
statistically not significant ( $p > 0.05$ ). It was observed that there was significant difference in weights of the rabbits in normal and experimental control groups after 12 weeks of the experiment. There was also significant difference when the test and the standard drug groups were compared to the

experimental control group ( $p < 0.05$ ). **Table 4** shows the effect of EEBBS on body weights of rabbits. **Fig. 4** shows the comparison of body weights in the individual groups before and after treatment.

**TABLE 4: EFFECT OF EEBBS ON BODY WEIGHTS OF RABBITS**

Groups	Mean body weight (g)				
	On 1 <sup>st</sup> day	After 12 <sup>th</sup> week	Change	% of increase	% of decrease
Normal Control	1694 ± 114.2	1720 ± 24.99	26	1.55	--
Experimental Control	1662 ± 118.1	1939 ± 63.79 <sup>a</sup>	277	16.67	--
Test Drug	1635 ± 53.29	1794 ± 66.27 <sup>b</sup>	159	9.72	--
Standard Drug	1617 ± 43.11	1721 ± 51.22 <sup>b</sup>	104	2.99	--

Values are expressed as MEAN ± SD (n=5). Paired t test was done <sup>a</sup> $p < 0.05$ , when compared to the Normal Control Group. <sup>b</sup> $p < 0.05$ , when compared to the Experimental Control Group.



**FIG. 4: EFFECT OF EEBBS ON BODY WEIGHT**

**RESULTS AND DISCUSSION:** Coronary Vascular Diseases are one of the major causes of mortality and morbidity in the world. Hyperlipidemia, a condition of excessive lipids in the body is one of the major predisposing factors. Oxidative stress is also was undertaken in an attempt to understand the potential medicinal benefits of *Bambusa balcooa* and to evaluate whether it had significant hypolipidemic and antioxidant benefits.

It was seen that continuous administration of high fat diet for 12 weeks to rabbits of the experimental control group showed a significant increase in total cholesterol (TC); triglycerides and LDL cholesterol while showing a significant decrease in the level of HDL cholesterol in comparison to the normal control group. Similar rise in lipid parameters were noted by Murty *et al* who induced hyperlipidemia in rabbits by using 1% w/w cholesterol and 10%

v/w groundnut oil <sup>29</sup>. However, the fall in HDL levels noted by them in their study, in the experimental control group was not significant as compared with the normal group. M. T. Sampathkumar *et al*, 2011 in their study; induced hyperlipidemia in rats by giving high fat diet containing cholesterol (2%), cholic acid (1%), dalda (20%), and coconut oil (6%) as major constituents. They found similar results for TC, TG, LDL-C, and HDL-C levels in hyperlipidemic rats treated with vehicle alone <sup>30</sup>.

Epidemiological studies suggest that high dietary intake of polyphenols is associated with decreased risk of a range of diseases including cardiovascular disease (CVD), specific forms of cancer and neurodegenerative diseases. In particular, a group of polyphenols known as flavonoids have been strongly linked with beneficial effects in many human, animal and *in-vitro* studies <sup>31</sup>.

There is a strong association between the risk of Coronary Artery Disease (CAD), high levels of LDL-C and low levels of HDL-C. Isolated elevation in triglycerides increases risk of CAD but its effect is counteracted by the levels of HDL-C. AIP may be an important tool for analyzing the results of clinical trials. The association of TGs and HDL-C in this simple ratio theoretically reflects the balance between risk and protective lipoprotein forces, and both TGs and HDL-C are widely measured and available. Although an independent, inverse relationship between HDL-C and cardiovascular risk has been demonstrated beyond any doubt, the contribution of TGs to cardiovascular risk has been underestimated. This may have been attributable to the high variability of plasma TG concentrations (which decreases the statistical significance of assessments), the lack of information on the role of TGs in biochemical mechanisms, or the incessant efforts to find an atherogenic marker independent of other lipids. The AIP, which is a mathematical relationship between TG and HDL-C has been successfully used as an additional index when assessing cardiovascular risk factors<sup>32</sup>. It has been suggested that AIP values of -0.3 to 0.1 are associated with low, 0.1 to 0.24 with medium and above 0.24 with high risk of CVD. In our study we found the AIP of the experimental control group is very high (~0.8). But in the EEBBS and atorvastatin treated groups, the AIP was reduced significantly compared to the experimental control group (~0.23 and ~0.17 respectively) though still came under the medium risk category. Flavonoids also have the capacity to bind with bile acids and bile salts that enhance their removal. Thus, the degradation of cholesterol may be more than its synthesis in the treated animals<sup>33</sup>.

Phytosterols are naturally occurring plant sterols that are structurally similar to cholesterol. The lipid-lowering benefit of phytosterols was the basis for the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) recommendation for adults to consume 2 g phytosterols daily to reduce LDL cholesterol and cardiovascular disease risk<sup>34</sup>. With the aid of the above literature we can hypothesize that the antihyperlipidemic activity of *B. balcooa* could be attributed, to the hypolipidemic activities of various polyphenols and flavonoids, phytosterols and plant proteins present in the plant extract.

In our study we have also observed that after continuous administration of high fat diet in the rabbits of the experimental control group, the catalase and the SOD activities were significantly decreased compared to the normal control group. There was also a significantly higher level of MDA in the experimental control group than the normal control. Upon treatment with the EEBBS and atorvastatin, reversal of these changes were seen with significantly increased catalase and SOD activities and reduced MDA levels in the serum of the rabbits of the test drug group and the standard drug group. When the test drug group was compared with the standard drug group, it was observed that catalase and SOD activities were significantly higher in the test drug group but the changes in the MDA levels were not significant ( $p>0.05$ ).

Malondialdehyde (MDA) is an end-product of the radical-initiated oxidative decomposition of polyunsaturated fatty acids; therefore, it is frequently used as a biomarker of oxidative stress. In human Catalase and superoxide dismutase are considered the first line of defense against free radicals. From the above discussion it may be postulated that the antioxidant activities shown by the *B. balcooa* extracts may be due to the presence of polyphenols, specially flavonoids in it.

The final body weight of rabbits in all the study groups were increased than their initial body weight. The increase was significant only in the experimental control and the test drug groups while there was no significant increase in the normal control and the standard drug groups. When compared to the experimental control group the body weight of the test drug group was significantly less after 12 weeks.

Tannins are reported to be involved in growth regulations. Tannins could potentially inhibit the activity of lipases thereby lowering the body fat content<sup>35</sup>. The weight lowering potential of *B. balcooa* could at least partially be attributed to the presence of tannins found in the plant.

**CONCLUSION:** Thus, it can be concluded that *Bambusa balcooa* shows potential for development as a hypolipidemic and anti-oxidant drug. *Bambusa balcooa* can easily be found in most parts of the

world. In a nation like India, where the majority of the population still has limited access to quality healthcare due to lack of financial reserves, such a drug could prove to be an effective and economically viable alternative.

**Limitations:** Our study faced certain limitations in lacking gender based studies and exact sample size justification. Further elaborate studies are required to isolate the lead compound responsible for the studied properties and carry out complete preclinical and clinical trials including dose-effect, gender based and toxicology studies that will provide more comprehensive data regarding its exact mode of action and therapeutic potential.

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**CONFLICTS OF INTEREST:** Nil

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