**Original Research Article**

**An Evaluation of Anti-hyperlipidemic Activity of *Bombax ceiba* Leaves on Hyperlipidemic Rat Model**

**Abstract**

Traditional medicine, as delineated by the World Health Organization, comprises the collective knowledge, skills, and practices rooted in cultural theories, beliefs, and experiences, and is extensively utilized for health maintenance and the treatment of physical and mental ailments. Hyperlipidemia, a prevalent metabolic disease frequently caused by the overconsumption of high-fat foods, presents significant health hazards. Although statins are the principal pharmaceutical intervention, their side effects and expense have stimulated the pursuit of better, natural options. *Bombax ceiba*, a medicinal herb historically employed in Asia for several therapeutic purposes, has recently garnered interest for its possible lipid-regulating capabilities. This study assessed the impact of an ethanolic extract of *Bombax ceiba* on lipid profiles in rats subjected to hyperlipidemia via a high-fat diet. The examination evaluated factors such as HDL, LDL, total cholesterol, triglycerides, SGPT, SGOT, urea, and creatinine. The results indicated that HDL and LDL levels did not produce statistically significant outcomes (p < 0.05). ANOVA analysis detected no statistically significant differences in total cholesterol levels among groups. Nonetheless, urea and creatinine concentrations in groups 5 and 6, which were administered *Bombax ceiba* extract at 600 and 900 mg/kg, respectively, exhibited statistically significant results (p < 0.05). Furthermore, the significant improvement in SGPT and SGOT levels in these groups (p < 0.05) indicates a promising enhancement in liver function. The observed significant difference in triglyceride levels (p < 0.05) between groups 5 and 6 further supports the dose-dependent lipid-lowering effects of the extract. These findings underscore the potential of *Bombax ceiba* as a natural therapeutic agent for managing hyperlipidemia. However, further research is needed to isolate active components and elucidate the underlying mechanisms to keep the audience engaged and interested.

**Keywords**: *Bombax ceiba*, hyperlipidemia, lipid profile, high-fat diet, traditional medicine, liver function, statistically significant.

**Introduction**

As the largest glandular organ, the liver controls most bodily physiological processes. The organ filters an individual's total blood volume multiple times daily, making it indispensable for human metabolic processes [1, 2]. The liver's significance is further underscored by the fact that excessive alcohol intake, substance dependence, exposure to hazardous substances, or infection by viruses or parasites can lead to increased levels of reactive oxygen species (ROS), such as OH, H2O2, and O2, potentially causing hepatocellular injury. This underscores the critical need for a deeper understanding of the liver's role in metabolism and the implications of its dysfunction. The Centers for Disease Control and Prevention conducted a study involving 1,492 doctors providing ambulatory care in non-governmental facilities. The study found that hyperlipidemia is the second most common chronic ailment among these professionals, after hypertension [4]. The study found that high-fat diets promote hyperlipidemia [5]. Common anti-hyperlipidemic medications like atorvastatin, pravastatin, fluvastatin, simvastatin, lovastatin, and rosuvastatin are primarily metabolized by the liver. As a result, the bioavailability of these medications is markedly restricted [6]. The enzyme 3-hydroxy-3-methylglutaryl-coenzyme A reductase (HMG-CoAR) can temporarily inhibit the activity of Statins. This enzyme lowers cholesterol by reducing cell cholesterol synthesis. Statins can penetrate hepatocytes and inhibit HMG-CoA reductase, which underlies their pharmacological effects.

Statins-associated muscle symptoms (SAMS), also referred to as muscular issues, are the predominant adverse effect that restricts statin usage. The emergence of diabetic mellitus (DM) and CNS problems is two additional potentially harmful outcomes [8]. Patients who must take these synthetic medications for the duration of their therapy may experience financial difficulties due to their high cost and significant side effects [9]. Consequently, efficient anti-hyperlipidemic drugs with few side effects are essential [10]. However, there is hope on the horizon. Plants, with their rich array of naturally occurring compounds, are proving to be a promising source of innovative treatments. With their therapeutic potential, medicinal plant chemicals are a beacon of hope in the search for new, effective herbal cures and other plant-based medicines to treat various ailments. For centuries, many cultures have employed herbal remedies, nutritional supplements, and alternative medicine. Many people now use traditional medicine for most healthcare needs [11]. The chemical ingredients of medicinal plants allow them to have several pharmacological and therapeutic effects. These ingredients include tannins, glycosides, alkaloids, saponins, polysaccharides, essential oils, terpenoids, resins, and plant lipids [12–14]. Genetically altered plants precisely regulate chemical concentrations, therefore aiding in achieving the desired medical effect. Reverse genetics can boost secondary metabolite synthesis, including alkaloids [15]. Global scientific progress has resulted in a heightened exploration of the medicinal properties of plant species [16]. Plants are in demand due to their safety, potency, and cost-effectiveness compared to synthetic medications.

*Bombax ceiba* Linnaeus is a tall, deciduous tree belonging to the family Bombacaceae. Bombacaceae, encompassing Bombax, Baobab, and Kapok genera, constitutes a diminutive family of flowering plants named after Bombax. It comprises around 25 genera and 250 species of tropical plants. *Bombax ceiba* is a prominent species among roughly 26 species and nearly 140 pantropical classifications. It is located at elevations of up to 1500 meters and can attain heights of up to 45 meters [17]. It is distributed throughout temperate and tropical regions of Asia, Africa, and Australia. Usually referred to as the silk cotton tree, its native names include shalmali (Sanskrit), shimul (Bengali), Indian kapok tree (English), and shamimin (Egyptian) [18]. The plant is commonly grown as an ornamental and shade tree in China, Pakistan, India, Austria, and Egypt [19]. Its fruit's smooth white fibers and medicinal properties are economically significant in producing mattresses, pillows, and soft toys, and serving as oil absorbents for oil spill remediation [20]. This dual utility underscores the plant's value and versatility. Traditional medicine recommends it for diarrhea, fever, hepatitis, impotence, and bladder and kidney ulcers [21]. The herb is renowned among tribal communities for its efficacy in treating numerous human and animal ailments. Reports show antioxidative, anti-inflammatory, antihyperglycemic, anti-hyperlipidemic, immunomodulatory, and hepatoprotective properties [22].

Herbalists employ every aspect of this plant as medication, making it the "silent doctor" [23]. Recognized as an ethnomedicinal plant, it is noted for its abundance of active constituents, including polysaccharides, phenolics, flavonoids, and neolignans [24]. *Bombax ceiba* leaves contain bioactive substances like C-flavonol glucoside and triterpenoid chemicals with hypoglycemic and anti-hyperlipidemic actions [25]. The ethanolic extract of *Bombax ceiba* exhibited a high concentration of flavonoids, phenolic compounds, and tannins [26, 27]. These significant molecules provide BCE's robust antioxidant and anti-hyperlipidemic characteristics in hepatic tissues [28]. In particular, plant-derived flavonoid and phenolic acid compounds are effective anti-hyperlipidemic medicines with vast supplies and facile collection, making them promising research hotspots. The potential for further research in this area is vast and promising, offering exciting opportunities for future studies [29].

To avert metabolic problems associated with obesity, we investigated the biochemical and histological anti-hyperlipidemic properties of *Bombax ceiba* extract in obese rats. Upon finding the active compounds, a thorough examination, encompassing additional investigations into the mechanism of action, possible adverse effects, and dosage optimization, may be undertaken to comprehensively evaluate *Bombax ceiba*'s therapeutic potential.

**Materials and Methods**

**Plant Collection and Extract Preparation**

Samples of *Bombax ceiba* were obtained from a local market in Dhaka. The National Herbarium of Bangladesh has verified the sample's validity. Initially, *Bombax ceiba* was thoroughly rinsed with water and then allowed to air dry. Ultimately, we pulverized the desiccated leaves into a fine powder. The powder was immersed in a 70% ethanol solution for 15 days. The solution was retained for 15 days. Intermittent, forceful tremors were also observed. The solution was subsequently filtered. The obtained filtrate was dried using a rotary evaporator under reduced temperature and pressure conditions. The crude leftovers underwent the necessary pharmacological investigation.

**Drugs and Chemicals**

The atorvastatin medication was acquired as a complimentary sample from Incepta Pharmaceuticals. Ethanol was purchased at the Taj Scientific store.

**Experimental Animal Procurement, Nursing, and Grouping**

Ninety male rats weighing 120 and 150 grams were obtained from Jahangirnagar University in Savar, Dhaka. The specimens were preserved in a regulated environment with a temperature range of 25±3°C, relative humidity of 55±5%, and a 12-hour light-dark cycle. The University of Dhaka's Institute of Nutrition and Food Science (INFS) offered this facility. The subjects received regular meals and were allowed to consume filtered water. Each animal was housed in this environment for at least one week before the study to observe their adaptation. The experimental protocols adhered to the guidelines the Institutional Animal Ethics Committee (IAEC) set forth. Ninety rats were randomly allocated into nine groups, each including ten rats.

**Experimental Design**

The investigation of atorvastatin's anti-hyperlipidemic efficacy is of significant importance. Rats were individually weighed and divided into nine groups, each with five rats. The allocation of the animals was based on their weight, as presented in **Table 1**. The atorvastatin control group, comprising rats administered atorvastatin alongside a high-fat diet, was designed to avoid the potential lethality of the medication if administered in isolation. The value of N/A indicates the existence or absence of a treatment in this group of rats.

**Table 1:** Anti-hyperlipidemic activity analysis

|  |  |  |  |
| --- | --- | --- | --- |
| **Group number** | **Group Status** | **Treatment specimen & Dose** | **Group Abbreviation** |
| 1 | Negative Control | Physiological Saline | N |
| 2 | HFD Control | High Fat Diet | P |
| 3 | High Fat Diet + AV10 | High Fat Diet + Atrovastatin | HFD + ATV |
| 4 | High Fat Diet + *B. ceiba* | High Fat Diet + BC300 | HFD + BC300 |
| 5 | High Fat Diet + *B. ceiba* | High Fat Diet + BC600 | HFD + BC600 |
| 6 | High Fat Diet + *B. ceiba* | High Fat Diet + BC900 | HFD + BC900 |
| 7 | *B. ceiba* | BC300 | BC300 |
| 8 | *B. ceiba* | BC600 | BC600 |
| 9 | *B. ceiba* | BC900 | BC900 |

**Table 2:** Composition of high fat diet

|  |  |
| --- | --- |
| **Food Ingredients** | **Composition** |
| Lipid (50%) | Milk powder (10%)Ghee (30%)Mutton fat (40%)Coconut oil (10%)Butter (10%) |
| Carbohydrate (40%) | Boiled rice (40%)Smashed potato (40%)Boiled corn (20%) |
| Protein (10%) | Dry powdered prone (40%)Dry boiled mutton (20%)Cheese (20%)Egg (20%) |

After mixing the ingredients thoroughly, the high fat diet was given to the rats to induce obesity for 10 weeks [30].

**Evaluation of Anti-hyperlipidemic Activity**

**Table 3:** Application of treatment efficacy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Group Number** | **Group Specification** | **Treatment species** | **Dose treatment species (mg/kg)** | **Abbreviation of Groups** |
| 1 | Negative Control | Physiological Saline | 10 ml/kg | N |
| 2 | High Fat | N/A | N/A | HF |
| 3 | HF + RV10 | Rovast 10mg/kg | 10 | RV10 |
| 4 | HF+ BC300 | *B. ceiba* | 300 | BC300 |
| 5 | HF + BC800 | *B. ceiba* | 600 | BC600 |
| 6 | HF + BC900 | *B. ceiba* | 900 | BC900 |
| 7 | BC300 | *B. ceiba* | 300 | BC300 |
| 8 | BC600 | *B. ceiba* | 600 | BC600 |
| 9 | Bc900 | *B. ceiba* | 900 | BC900 |

 For this experiment, 100 rats were randomly picked and equally divided into fourteen groups

**Statistical Analysis**

The numerical parameters we collected were documented and analyzed on a spreadsheet using the widely used MS Excel application, demonstrating our practical approach to data analysis. The gathered data underwent descriptive statistical analysis, with results presented as the mean and standard deviation (SD). We utilized the 'One-way ANOVA test' function of SPSS 16 software to evaluate statistical significance in studying inter-group variability of various biological parameters. The events are deemed statistically significant as the 'p' value is below 0.05 (p < 0.05).

**Results and Discussion**

Traditional medicine and ethnomedicine, encompassing the medicinal knowledge and practices of various ethnic communities, have been essential to human health care since antiquity. Historically, these systems have depended significantly on natural resources, especially plants and herbs, to prevent and treat several illnesses. Herbal treatments and phytotherapeutic preparations constituted the foundation of early medical techniques throughout various cultures and civilizations. Over time, botanical resources have not only endured but also played a crucial role in advancing contemporary pharmaceuticals, either via traditional formulations or by extracting bioactive chemicals. The sustained significance of these practices underscores the necessity for ongoing scientific investigation into plant-based medicines, which is crucial in validating their efficacy. This study assessed the impact of *Bombax ceiba* extract on lipid profile markers in rats with diet-induced hyperlipidemia, seeking to explore its potential as a natural therapeutic agent for lipid diseases.

**Table 4:** Value different blood parameter of Rodents belonged to different groups

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Groups** | **SGPT** | **SGOT** | **Creatinine** | **Urea** | **TC** | **HDL** | **LDL** | **TG** |
| NC | 33.49±3.42 | 37.52±3.51 | 0.63±0.19 | 36.21±1.57 | 128.29±5.04 | 84.24±3.91 | 39.52±4.07 | 43.28±2.71 |
| HFD | 85.35±7.83 | 88.24±8.24 | 3.02±0.82 | 97.08±7.93 | 229.73±9.50 | 47.53±5.04 | 151.29±13.28 | 124.28±8.51 |
| HFD+AV10 | 52.57±6.91 | 57.18±5.29 | 1.47±0.37 | 62.50±6.71 | 158.25±7.91 | 69.32±5.22 | 127.58±10.29 | 65.19±6.99 |
| HFD+BC300 | 83.27±5.89 | 86.17±4.97 | 2.87±0.61 | 94.71±6.28 | 220.54±7.25 | 48.50±6.01 | 148.25±9.21 | 118.28±7.28 |
| HFD+BC600 | 80.62±7.01 | 85.71±5.76 | 2.38±0.93\* | 90.27±6.41\* | 221.53±9.02 | 52.91±6.18 | 146.71±8.97 | 111.72±6.28\* |
| HFD+BC900 | 77.82±6.21\* | 81.62±6.02\* | 1.96±0.87\* | 87.47±7.04\* | 202.36±8.69 | 57.91±3.30 | 143.95±9.91 | 103.41±9.02\* |
| BC300 | 31.20±1.18 | 35.25±4.62 | 0.57±0.81 | 34.34±2.08 | 125.08±4.71 | 82.70±4.05 | 35.35±4.28 | 47.50±3.21 |
| BC600 | 33.41±2.91 | 33.21±2.07 | 0.67±0.53 | 37.91±3.25 | 129.90±6.05 | 80.80±3.81 | 38.77±3.78 | 44.19±1.91 |
| BC900 | 34.28±3.76 | 35.35±3.08 | 0.66±0.48 | 36.17±2.93 | 132.22±5.05 | 82.96±4.76 | 34.25±4.13 | 45.41±2.38 |

When conducting the liver function test, every detail was meticulously examined. It was found that neither the high-density lipoprotein (HDL) nor the low-density lipoprotein (LDL) levels produced statistically significant results (p < 0.05). The analysis of variance (ANOVA) test showed no statistically significant variation in total cholesterol levels. Two other studies [31, 32] yielded the same findings. However, the Urea and Creatinine levels investigation demonstrated statistically significant outcomes (p < 0.05) in groups 5 and 6, where the dosage of high fat and extract provided was 600 and 900 mg/kg, respectively. Additional investigations [33] yielded congruent conclusions about the topic. Despite both groups being administered 600 and 900 mg/kg doses, the SGPT and SGOT results were statistically significant (p < 0.05) for Groups 5 and 7, respectively. The results contradict the two additional tests [34, 35] done in this instance. The most important discovery, however, was that there was a statistically significant difference (p < 0.05) in the levels of triglycerides between groups 5 and 6.

**Conclusion**

This study examined the anti-hyperlipidemic properties of an ethanolic extract of *Bombax ceiba*. The findings indicate that an ethanol extract of the *Bombax ceiba* plant may offer protection against hypercholesterolemia, hepatic damage, and renal failure. Further research is necessary to ascertain the specific active constituents in the whole extract that may mitigate hyperlipidemia and diabetes. After identifying the active chemicals, a comprehensive analysis may be conducted.

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