*Original Article*

# Lipid Lowering Effect of Methanol Extract of Stem of *Musa sapientum* (Banana) in Cholesterol Fed Rats

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**ABSTRACT**

*Dyslipidemia is a common metabolic disorder in clinical practice that may lead to a number of subsequent diseases including coronary heart disease (CHD), dermatological manifestations, pancreatitis, neurological and ocular abnormalities. An experimental study was conducted in the Department of Pharmacology & Therapeutics, Dhaka Medical College, Dhaka, Bangladesh, to investigate the lipid lowering effects of methanol extract of the stem of banana (Musa sapientum) in hypercholesterolemic rats. This study also compared the cholesterol lowering effect of methanol extract of the stem of Musa sapientum (Msmt) with atorvastatin, a lipid lowering agent. In this experiment, total thirty (30) rats were divided into 5 groups. There were 6 rats in each group. Group A served as control group, and received a normal diet and water. Group B received a normal diet, water and cholesterol diet, while Group C received a normal diet, water, cholesterol and Msmt (20 mg/kg/day), Group D received a normal diet, water, cholesterol diet and Msmt (40 mg/kg/day), and Group E received a normal diet, water, cholesterol and atorvastatin (0.18 mg/kg/day). After 14 days, blood samples of rats were collected by cardiac puncture and analyzed to observe the change in cholesterol level in experimental rats. Lipid profile showed that serum TC, LDL, TG levels significantly decreased in both Msmt and atorvastatin along with cholesterol fed Group C, D and E ($p<0.001$) in comparison to only cholesterol fed Group B, but maximum effect was observed in atorvastatin fed Group E. Serum HDL level significantly increased in Group C, D and E ($p<0.001$) in comparison with Group B. Our study showed that Msmt and atorvastatin both decreased total cholesterol and increased HDL cholesterol.*

**Keywords:** *Dyslipidemia, lipid lowering effect, atorvastatin, stem of* Musa sapientum *(Banana)*

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## INTRODUCTION

Hypercholesterolemia is one of the common metabolic disorders in developed countries as well as in developing countries, including Bangladesh. Increased serum cholesterol plays a role in etiology and the course of atherosclerosis, which may lead to a number of sequels, including coronary heart disease (CHD), dermatological manifestations, pancreatitis, neurological and ocular abnormalities.[1]

Cholesterol is amphipathic in nature; consisting of a polar head group (the hydroxyl group at C3) and a nonpolar hydrocarbon body (the hydrocarbon side chain at C17 and the steroid nucleus) which may be as long as a 16-carbon fatty acid in its elongated conformation.[2] The administration of cholesterol in rats has been shown to enhance hepatic lipid metabolism and triglyceride levels. Thus, the increase in total serum cholesterol stands as a major cause of impairment in triglyceride metabolism which leads to the accumulation or deposition of free fatty acids in the liver, generating a disorder known as fatty liver.[3] Expansion in the liver fatty acid pool leads to an

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increase in peroxisomal and mitochondrial β-oxidation, which results in the production of reactive oxygen species, which may in turn stimulate the generation of a local proinflammatory state that causes a progression in the liver injury.[4]

The adverse effects of an increase in cholesterol levels in the body have been linked to several life-threatening diseases, such as hypertension, atherosclerosis, cardiovascular diseases, metabolic syndrome, obesity, hypercholesterolemia as well as diabetes.[5-7] Hypercholesterolemia refers to a metabolic disorder which is caused by an elevated level in the concentrations of plasma low density lipoprotein (LDL) cholesterol.[8] Type-2-diabetes mellitus, alcohol, dialysis, monoclonal gammopathy, hypothyroidism, anorexia nervosa, nephrotic syndrome, Cushing's syndrome, obstructive jaundice, and medications such as; thiazide diuretics, glucocorticoids, ciclosporin and retinoic acid beta blockers are some of the secondary causes of hypercholesterolemia.[4,9,10]

Herbal agents such as garlic oil, onion, karela, tulsi leaves, hilsa fish oil, rice bran oil, arjun tree bark powder, banana tree stem, (the stem of *Musa sapientum*) have been selected to find its hypocholesterolemic effect. Such as medicinal properties of *Musa sapientum* are largely overlooked. All parts of this plant possess medicinal activities which are helpful in curing many human ailments. Many traditional medicinal systems (Ayurveda and Chinese) discuss about the medicinal and healing properties of *Musa sapientum*.[11] *Musa sapientum* which belongs to the family *musaceae* are one of the most important foods in the world. Bangladesh is an agricultural country. More than 80% people directly depend on agriculture.[12] In mammals, banana stem (BS) extract shows hepatoprotective effects, anti-hyperglycemic, anti-hypercholesterolemic and other medicinal properties.[11,13] Available reports suggest that methanol extract of stem of *Musa sapientum* has significant antihypercholesterolemic effects in cholesterol fed rats. It has been found to have significant antihypercholesterolemic and antioxidant effects.[11]

Cardiovascular diseases (CVDs) remain a leading cause of morbidity and mortality worldwide, with hyperlipidemia being a major risk factor. Elevated levels of total cholesterol, low-density lipoprotein (LDL), and triglycerides are strongly associated with atherosclerosis and subsequent cardiac events.[8] While synthetic lipid-lowering agents like statins are commonly used, they often come with significant side effects and high costs, especially in resource-limited settings.[8] However, limited studies have explored the lipid-lowering potential of the stem extract, particularly in a controlled experimental model. The methanol extract of the banana stem may contain bioactive phytochemicals such as flavonoids, polyphenols, and sterols that can modulate lipid metabolism.[1,11] Investigating its efficacy in cholesterol-fed rats provides a scientific basis for its potential use as a natural, affordable alternative for managing hypercholesterolemia. Therefore, this study was done to evaluate the lipid lowering effects of *Musa sapientum,* subspecies *Sylvestris* (commonly known as "atti kola" or "bitchi kola") in cholesterol fed rats and to establish its importance in the prevention of hypertension, atherosclerosis, coronary artery disease (CAD) and cerebrovascular diseases (CVD).

## METHODS

This experimental study was carried out in the Department of Pharmacology & Therapeutics, Dhaka Medical College, Dhaka, Bangladesh, on adult male Wistar Albino rats with methanol extract of Stem of *Musa sapientum* (Banana) for 14 days. A total number of 30 healthy adult male Wistar albino rats of both sexes with 10-12 weeks of age weighing approximately 150-200 grams were randomly divided into 5 groups. Each group comprised of 6 rats and all the numbers were given standard normal diet. Group A was provided with a normal diet and water and served as control. Group B received normal diet, water and cholesterol suspended in soya oil (100 mg/kg/day), while Group-C received normal diet, water and cholesterol suspended in soya oil (100 mg/kg/day) and Msmt (20 mg/kg/day), Group D received normal diet, water and cholesterol suspended in soya oil (100 mg/kg/day) and Msmt (40 mg/kg/day), and Group E was provided with a normal diet, water and cholesterol suspended in soya oil (100 mg/kg/day) and atorvastatin (0.18mg/kg/day). All the groups were treated for 14 days.

Fresh stem of *Musa sapientum* was collected from Purbachal local area under Narayanganj district. It was identified and authenticated by Bangladesh

National Herbarium (BNH) and given a DACB accession number – 87590. The upright concentric layer of leaf sheaths forming pseudo stem was peeled off from freshly cut the stem of *Musa sapientum* to reveal the central pale white stem. Stem was chopped into small pieces. The chopped stem was then air dried for 3-5 days. After that the stem was soaked with 99% methanol in a bottle for 5 days with several times shaking each day. After 5 days extract was collected by cotton filtering the soaked materials. A dark brown red colored liquid was obtained. Then it was dried in a rotator vacuum evaporator (BUCHI Labor Technik AG, CH-9230 Flawil Switzerland, Type: R- 215). A crude extract of *Musa sapientum* was obtained as dark brown red thick gel like substance which was then stored in a glass bottle in the refrigerator at 4°C until further use. This crude extract of *Musa sapientum* was dissolved in distilled water at the time of use.[11]

Tablet atorvastatin (10 mg), Batch No. 49308601 was purchased from a local pharmacy in Dhaka. The medicine was manufactured by Beximco Pharmaceuticals Ltd., Bangladesh. Tablet was crushed into powder and weighted according to the body weight of rats to be treated. Total 20.5 mg was dissolved in 85 ml distilled water. Therefore, 0.75 ml of distilled water per rat (average weight 175 gm) contains 0.18 mg atorvastatin.

On 14th day of treatment, animals were sacrificed under chloroform anesthesia and approximately 3-4 ml of blood from each rat was collected in a clean and dry test tube. Rat was placed on its back. Then the heart was palpated by the left index finger at the level of lowest ribs, without applying any pressure. Holding the syringe at a 45° angle, a needle was inserted between two ribs. Without moving the syringe, a plunger was pulled on to fill the syringe. Once the syringe became full, it was disconnected from the needle and emptied it into a tube.[13] Immediately after blood collection, the rat was euthanized. Then the blood samples were allowed to clot for 30 minutes and the serum was separated by centrifugation. For biochemical analysis, the serum was taken to the Department of Clinical Pathology of the same institution to analyze serum lipid profile. The estimated biochemical parameters were: serum total cholesterol (TC), triglycerides (TG), LDL, and HDL.

| **Total no of rats-30** | | | | |
|---|---|---|---|---|
| Group A n=6 | Group B n=6 | Group C n=6 | Group D n=6 | Group E n=6 |
| Received normal diet and water for 14 days | Received normal diet, water and cholesterol suspended in soya oil (100mg/kg/day) for 14 days | Received normal diet, water, cholesterol suspended in soya oil (100 mg/kg/day) and Msmt (20mg/kg/-day) for 14 days | Received normal diet, water, cholesterol suspended in soya oil (100 mg/kg/ day) and Msmt (40mg/kg/day) for 14 days | Received normal diet, water, cholesterol suspended in soya oil (100 mg/kg/ day) and atorvastatin (0.18 mg/kg/day) for 14 days |
| On 14th day of treatment, serum lipid profile was measured | | | | |

Data was collected in a data collection form. The results were expressed as mean±SD. Statistical significance of different groups were determined by one-way ANOVA, followed by Bonferroni test. Statistical calculation was performed by using Statistical Package for Social Sciences (SPSS) version 26.0 for Windows. Results of intervention groups were compared with that of control group. Statistical significance was considered at $p \leq 0.05$.

The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka, Bangladesh.

**RESULTS**

The mean serum total cholesterol (TC) levels were observed 108.33±9.31mg/dl, 151.33±7.79 mg/dl, 127.25±4.79 mg/dl, 121.17±6.15 mg/dl, and 117.33±5.05 mg/dl in group A, B, C, D and E respectively. The difference was statistically significant between group A & B, B & C, B & D and B & E ($p<0.001$). The mean triglyceride (TG) levels were found 81.33±7.47 mg/dl, 138.83±7.63 mg/dl, 93.50±16.05 mg/dl, 78.67±7.79 mg/dl, and 73.67±5.89 mg/dl in group A, B, C, D and E respectively. The difference was statistically significant between group A & B, B & C, B & D and B & E ($p<0.001$). The mean HDL levels were found 36.53±2.98 mg/dl, 23.50±1.76 mg/dl, 32.42±3.17 mg/dl, 33.75±2.09 mg/dl, and 34.17±1.72 mg/dl in group A, B, C, D, and E respectively. HDL-C decreased in group B compared to group A, C, D and E. The difference was statistically significant between group A & B, B & C, B & D and B & E ($p<0.001$). The mean LDL-C levels were 43.00±5.22 mg/dl, 85.00±12.33 mg/dl, 48.17±4.45 mg/dl, 41.33±4.89 mg/dl, and 39.50±4.76 mg/dl in group A, B, C, D, and E respectively. The difference was statistically significant between group A & B, B & C, B & D and B & E ($p<0.001$). There was significant increase in serum total cholesterol (TC), triglyceride (TG) and LDL levels in the hypercholesterolemic group (group B). Groups treated with Msmt (i.e., group C and D) and atorvastatin (group E) showed significantly lower serum TC, TG, LDL levels compared to group B and of high dose of Msmt treated group (i.e., group D) was almost similar to atorvastatin. The induction of *Msmt* significantly increased ($p<0.001$) the levels of serum HDL. The high dose of *Msmt* treated group (group D) significantly ($p<0.001$) increased the level of HDL and nearly similar to the atorvastatin treated group (group E) (see Table-I & II).

**Table-I:** *Comparison of serum lipid profile among different experimental groups (N=30)*

| Lipid | Group A | Group B | Group C | Group D | Group E | p-value |
|---|---|---|---|---|---|---|
| profile | (n=6) | (n=6) | (n=6) | (n=6) | (n=6) | |
| TC (mg/dl) | 108.33±9.31 | 151.33±7.79 | 127.25±4.79 | 121.17±6.15 | 117.33±5.05 | <0.001*** |
| TG (mg/dl) | 81.33±7.47 | 138.83±7.63 | 93.50±16.05 | 78.67±7.79 | 73.67±5.89 | <0.001*** |
| HDL(mg/dl) | 36.53±2.98 | 23.50±1.76 | 32.42±3.17 | 33.75±2.09 | 34.17±1.72 | <0.001*** |
| LDL(mg/dl) | 43.00±5.22 | 85.00±12.33 | 48.17±4.45 | 41.33±4.89 | 39.50±4.76 | <0.001*** |

***=highly significant.

**Table-II:** *Comparison of serum lipid profile levels between groups*

| Group | TC | TG | HDL | LDL |
|---|---|---|---|---|
| Group A vs. Group B | <0.001*** | <0.001*** | <0.001*** | <0.001*** |
| Group B vs. Group C | <0.001*** | <0.001*** | <0.001*** | <0.001*** |
| Group B vs. Group D | <0.001*** | <0.001*** | <0.001*** | <0.001*** |
| Group B vs. Group E | <0.001*** | <0.001*** | <0.001*** | <0.001*** |
| Group C vs. Group E | $0.188^{NS}$ | 0.015* | $1.000^{NS}$ | $0.421^{NS}$ |
| Group D vs. Group E | $1.000^{NS}$ | $1.000^{NS}$ | $1.000^{NS}$ | $1.000^{NS}$ |

***=highly significant, *=significant, NS=not significant.

## DISCUSSION

The present study was conducted to investigate the cholesterol lowering effects of extract of stem of *Musa sapientum* (Banana) in hypercholesterolemic rats. This study also compared the cholesterol lowering effect of *Msmt* with lipid powering agent, atorvastatin. An important risk factor for coronary heart disease is hyperlipidemia and lipid lowering agent like atorvastatin can reduce the risk.[8] The present study showed that Msmt contains polyphenol and sterol which lowered the cholesterol, LDL-C, TG and elevated HDL. Thus, Msmt improved lipid abnormality and reduced the atherogenic index.

The serum TC levels were significantly decreased in both Msmt and atorvastatin along with cholesterol fed group C, D and E ($p<0.001$), but maximum effect was observed in atorvastatin treated group E. Serum TG levels were significantly decreased in both Msmt and atorvastatin along with cholesterol fed group C, D and E ($p<0.001$). Serum HDL levels were significantly increased in Msmt fed group C, D and atorvastatin treated group E. Serum LDL levels were significantly decreased in both Msmt and atorvastatin along with cholesterol fed group C, D and E ($p<0.001$) in comparison to only cholesterol fed group B, but maximum effect was observed in atorvastatin treated group E. Those results are consistent with the findings from two other separate studies done by Dikshit et al.[10] and Gomathy et al.[14] Apart from that, Dikshit et al.[10] also reported that Msmt had significant hypolipidemic, antihypercholesterolemic and antioxidant effects. Moreover, Msmt interfered with intestinal absorption of cholesterol and stimulation of hepatic lipases and suppression of cholesterol biosynthesis by possible inhibition of HMG CoA reductase might also be responsible for the hypolipidemic effects of methanol extract of the stem of *Musa sapientum*. Similarly, Gomathy et al.[14] showed that extract of the stem of *Musa sapientum* administration to cholesterol fed rats significantly lowered cholesterol and triglycerides in serum, liver and aorta. However, the lipid lowering effects of Msmt in the present study was found to be dose dependent. In higher dose levels (i.e., 40 mg/kg/day) of *Msmt* showed much more lipid lowering effect than that with lower dose (i.e., 20 mg/kg/day). Significant increase in serum HDL levels was observed as well.

Our study has some limitations. Phytochemical screening of the experimental *Musa sapientum* extract was not done due to time and resource limitations. For the same reason, histopathological examinations of liver and blood vessels were not done.

## CONCLUSION

The results of the study revealed that the extract of *Musa sapientum* (Banana) stem consumption daily has a significant effect on lowering serum lipid levels (TC, TG, LDL). Thus, it could be useful in hyperlipidemic conditions, such as hypertension, atherosclerosis, coronary artery disease (CAD) and cerebrovascular diseases (CVD).

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