EFFECT OF *CASSIA TORA* SEED EXTRACT ON LIPID PROFILE OF HYPERLIPIDAEMIC RABBITS

Dixit M* and Trivedi P C**

* Reader, L.B.S. College of Pharmacy, Jaipur-302004, Rajasthan, India.

E-mail : dixit189@rediffmail.com

** Professor, Department of Botany, University of Rajasthan,

Jaipur-302004, Rajasthan, India.

Summary

Ethanolic extract (50%v/v) of *Cassia tora* seed extract has been investigated for the protective effects against experimentally induced hyperlipidaemia in rabbits. Hyperlipidaemia was induced in rabbits by feeding atherogenic diet containing coconut oil, hydrogenated vegetable oil and cholesterol for 90 days. Rabbits were divided into three groups, each group comprising of six rabbits. Group I served as normal control, Group II (hyperlipidaemic control) was fed with atherogenic diet and cholesterol (400 mg/kg bodyweight /day/rabbit), Group III was concurrently fed with *Cassia tora* seed extract (500 mg/kg bodyweight /day/rabbit) along with atherogenic diet and cholesterol.

Significant increase ($P<0.05$) in serum total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides was observed by feeding atherogenic diet and cholesterol to rabbits for 45 and 90 days. Simultaneous administration of *Cassia tora* seed extract significantly ($P<0.05$) prevented the rise in serum total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides level as compared to hyperlipidaemic control group.

Total cholesterol in liver (mg/ gm tissue) and heart (mg/ gm tissue) were increased significantly ($p<0.05$) in rabbits fed with atherogenic diet and cholesterol for 90 days. Concurrent administration of *Cassia tora* seed extract with atherogenic diet and cholesterol caused a significant decrease ($P<0.05$) in liver and heart in total cholesterol content. A significant increase ($P<0.05$) in cholesterol content of faeces (mg/ gm dry faeces) was observed in *Cassia tora* seed extract treated group as compared to hyperlipidaemic control group after 90 days.

Keywords: *Cassia tora,* cholesterol, anti-hyperlipidaemic, Lipid profile, Rabbits

Introduction

Cardiovascular diseases (CVD) are the most common cause of death worldwide. In Western countries where CVD is declining and is considered as a disease of the aged, 23 % of CVD deaths occur below the age of 70; this compares with 52% of CVD deaths occurring among people under 70 years of age in India (1,2).

Coronary heart disease (CHD) is the major cause of CVD mortality. The incidence of CHD is on an increase in the Indian subcontinent (including India, Pakistan, Bangladesh, Sri Lanka and Nepal). There is high rate of CHD mortality, CHD manifests almost 10 year earlier on an average in this region compared with the rest of the world, resulting in a substantial number of CHD deaths occurring in the working age group (3).

There is strong link between the elevated blood cholesterol (particularly LDL cholesterol) and the occurrence of CHD (4-8). In spite of the availability of various anti-hyperlipidaemic agents, there is increase in the incidence of CHD. The current investigations in the field of cholesterol lowering drugs are directed towards finding an efficacious, safe and economic hypolipidaemic agent. The currently available synthetic drugs are effective but they frequently produce side effects, some of which are of serious in nature. They are also very expensive and have poor patient compliance, which limit their usefulness on a long-term basis. Thus, there is still considerable interest in the evaluation of new anti-hyperlipidaemic agents (synthetic and herbal). Hence, the present study was undertaken to explore the hypolipidaemic activity of the plant *Cassia tora*, which is available as common weed in India.

Materials & Methods

Plant material:

Cassia tora Linn. (Fabaceae), is a herbaceous annual occurring as a weed throughout the country in plains, ascending 1500 m in the Central Himalayas (9). Seed is hard, 1 cm long, 3-4 mm thick, oblong or rhombohedral, both ends appear as if cut off obliquely, greenish-brown to brownish-black, smooth and shiny; odourless; taste, bitter.

Seeds contain β-sitosterol, emodin, rubrofusarin, 1,8-dihydroxy anthraquinone while leaves contain myricyl alcohol, β-sitosterol, β-sitosterol glucoside, stigmasterol, mannitol and a ketonic compound, C16H30O (m.p. 79-80°) (10).

Preparation of crude plant extract

The dried seeds of *Cassia tora* were crushed to moderately coarse powder. The drug powder was packed in soxhlet apparatus and was defatted with petroleum ether for 72 hours. The defatted material was completely freed of petroleum ether and the marc was extracted with ethanol 50% v/v till exhausted completely. The ethanolic extract so obtained was freed of solvent under vacuum.

Animal

Adult albino rabbits weighing between 1.5 and 2.0 kg of both sexes were used for the study. The animals were kept in cages with proper aeration and lighting for 10-14 days. During this

period they were given normal controlled diet consisting of wheat, rizka and water *ad libitum* until they got acclimatized in 10-14 days.

Experimental Design

Rabbits were divided into three groups, each group comprising of six rabbits. They were numbered for identification (Table 1).

Table 1: Group and treatment of rabbits

Group	No. of animals	Treatment
I Normal Control	6	Control, normal diet
II Hyperlipidaemic Control	6	Atherogenic diet + Cholesterol feeding (400 mg/kg body weight /day/rabbit)
III *Cassia tora*	6	Atherogenic diet + Cholesterol feeding (400 mg/kg body weight/day/rabbit) + *Cassia tora* (500 mg/kg body weight /day/rabbit)

Feeding Methodology:

Group I served as a normal control. Group II and III received atherogenic diet plus cholesterol powder 400 mg/kg body weight/ day/ rabbit in 5 ml oil mixture for 90 days. In addition, group III received drug, *Cassia tora* seed extract (50% ethanolic) at the dose 500 mg/kg body weight/day/rabbit.

Ingredients of Atherogenic diet:

Rizka green	60 gm
Wheat flour	50 gm
Vegetable Ghee	05 gm
Coconut oil	05 gm
Salt	04 gm
Cholesterol	0.4 gm/ kg body weight/rabbit/ day
Total	124.4 gm

The atherogenic diet consisted of supplementing the normal control diet with 400 mg cholesterol + 3ml hydrogenated vegetable oil + 2ml coconut oil per kg per day to each rabbit. The rabbits were subjected to this treatment for 90 days.

Blood Collection and Serum Separation:

Blood samples were taken initially, on 45th day and 90th day from each rabbit. No food was supplied for 12 hours before withdrawal of blood samples. Blood samples were taken from

the marginal ear vein of each rabbit (11). The serum was separated for lipid profile and other biochemical estimations.

Serum biochemistry:

Serum samples were analyzed for total cholesterol (12), HDL cholesterol (13) and triglycerides (14,15). LDL cholesterol was estimated indirectly after the estimation of total cholesterol, triglycerides, and HDL cholesterol by Friedwald's formula (16).

Tissue biochemistry:

At the end of 90 days, the rabbits were anaesthetized and tissues like heart and liver were removed for respective tests. Total cholesterol in liver and heart was estimated by the method of Zlatkis (17).

Faecal cholesterol

Total faecal matter of normal control, hyperlipidaemic control, and *Cassia tora* groups were collected daily during last week of experiments and was dried at 40°C. After weighing, a known quantity of dry faecal matter, was soaked in methanol and chloroform (1:1) for 24 hours and then filtered. This process was repeated three times so as to extract the entire lipid content of faeces (18). The lipid extract so obtained was used for the estimation of total cholesterol.

Statistical analysis:

All values are expressed as mean ± standard error of the mean (S.E.M.). Data was analysed by using a one way analysis of variance (ANOVA) followed by least significant difference (L.S.D.) procedure of significance, where appropriate. A value of $p < 0.05$ was the criterion of significance.

Results

Table 2-5 shows the values of serum total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides levels in normal control, hyperlipidaemic control and *Cassia tora* treated groups respectively. Serum total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides levels increased significantly ($p<0.05$) on 45^{th} and 90^{th} day in hyperlipidaemic control group. Furthermore, the total cholesterol: HDL-cholesterol ratio was increased significantly ($P<0.05$) on 90^{th} day (Table 6). The LDL-cholesterol: HDL-cholesterol ratio was also increased significantly ($P<0.05$) on 45^{th} and 90^{th} day (Table 7). Total cholesterol content in liver (mg/ gm tissue) and heart (mg/ gm tissue) were increased significantly ($p<0.05$) in hyperlipidaemic control group on 90^{th} day (Table 8). A significant increase ($p<0.05$) in total cholesterol in faeces was observed in hyperlipidaemic control group as compared to normal control group (Table 8).

Concurrent administration of *Cassia tora* seed extract (500 mg / kg b.wt./day) with atherogenic diet and cholesterol (400 mg / kg b.wt./day) caused a significant decrease ($p<0.05$) in the levels of serum total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides when compared with hyperlipidaemic control group rabbits on 45^{th} and 90^{th} day (Table 2-5). The ratios of total-cholesterol: HDL-cholesterol declined significantly ($p<0.05$)

on 90th day (Table 6). The LDL-cholesterol: HDL-cholesterol were declined non-significantly (p=n.s.) as compared to hyperlipidaemic control rabbits (Table 7). Total cholesterol content in liver (mg/ gm tissue) and heart (mg/ gm tissue) were decreased significantly ($p<0.05$) in *Cassia tora* treated group (Table 8). A significant ($p<0.05$) increase in cholesterol content of faeces (mg/ gm dry faeces) was observed in *Cassia tora* treated group as compared to hyperlipidaemic control group after 90 days (Table 8).

Table 2: Effect of *Cassia tora* seed extract on total cholesterol level (mg/dL) of rabbits

Treatment group	Total Cholesterol		
	Initial value	45th day	90th day
Normal Control	66.03 ± 2.54	71.30 ± 4.73	75.51 ± 3.57
Hyperlipidaemic Control (Deviation %)	73.14 ± 3.52	464.97±25.04* (+552.13%)	854.24±20.38* (+1031.29%)
Cassia tora (Deviation %)	72.24±3.92	179.49±11.22* (- 61.39%)	342.41±12.93* (-59.91%)

Each value represents Mean ± SEM. (n=6)

Statistical comparison:

Hyperlipidaemic Control vs. Normal Control, *Cassia tora* vs. Hyperlipidaemic Control

Significance levels: $p < 0.05$ = *, Not significant: p = n.s.

Values in parenthesis indicate percent increase (+) or decrease (-)

Table 3: Effect of *Cassia tora* seed extract on LDL cholesterol level (mg/dL) of rabbits

Treatment group	LDL Cholesterol		
	Initial value	45th day	90th day
Normal Control	28.32±1.24	31.46±1.64	32.06±2.22
Hyperlipidaemic Control	32.42±1.08	302.11±17.70* (+860.29%)	614.69±33.05* (+1817.31%)
Cassia tora	29.12 ± 1.56	112.34 ± 9.25* (- 62.81%)	236.27 ± 14.91* (- 61.56 %)

Each value represents Mean ± SEM. (n=6)

Statistical comparison:

Hyperlipidaemic Control vs. Normal Control, *Cassia tora* vs. Hyperlipidaemic Control

Significance levels: $p < 0.05$ = *, Not significant: p = n.s.

Values in parenthesis indicate percent increase (+) or decrease (-)

Table 4: Effect of *Cassia tora* seed extract on HDL cholesterol level (mg/dL) of rabbits

Treatment group	HDL Cholesterol level		
	Initial level	45th day	90th day
Normal Control	26.29±1.97	26.46±2.49	28.25±1.96
Hyperlipidaemic Control	28.30±2.02	126.78±10.94* (+379.13%)	185.93±12.95* (+558.15%)
Cassia tora	28.38 ± 1.89	49.90 ± 6.52* (- 60.64 %)	85.99 ± 4.31* (- 53.75 %)

Each value represents Mean ± SEM. (n=6)

Statistical comparison:

Hyperlipidaemic Control vs. Normal Control, *Cassia tora* vs. Hyperlipidaemic Control

Significance levels: $p < 0.05$ = *, Not significant: p = n.s.

Values in parenthesis indicate percent increase (+) or decrease (-)

Table 5: Effect of *Cassia tora* seed extract on triglycerides level (mg/dL) of rabbits

Treatment group	Triglyceride level		
	Initial level	45th day	90th day
Normal Control	57.04±2.94	66.33±4.47	75.38±4.12
Hyperlipidaemic Control	61.87±4.05	180.15±14.86* (+171.59%)	268.07±19.79* (+255.62%)
Cassia tora	73.14 ± 4.63	86.21 ± 6.73* (- 52.15 %)	100.82 ± 6.37* (- 62.39 %)

Each value represents Mean ± SEM. (n=6)

Statistical comparison:

Hyperlipidaemic Control vs. Normal Control, *Cassia tora* vs. Hyperlipidaemic Control

Significance levels: $p < 0.05$ = *, Not significant: p = n.s.

Values in parenthesis indicate percent increase (+) or decrease (-)

Table 6: Effect of *Cassia tora* seed extract on total cholesterol : HDL ratio in rabbits

Treatment group	Total Cholesterol : HDL		
	Initial value	45th day	90th day
Normal Control	2.55 ± 0.11	2.86 ± 0.40	2.75 ± 0.26
Hyperlipidaemic Control	2.69 ± 0.30	3.91 ± 0.57 *n.s.*	4.70 ± 0.32*
Cassia tora	2.56 ± 0.04	3.95 ± 0.56 *n.s.*	4.00 ± 0.07*

Each value represents Mean ± SEM. (n=6)

Statistical comparison:

Hyperlipidaemic Control vs. Normal Control, *Cassia tora* vs. Hyperlipidaemic Control

Significance levels: $p < 0.05$ = *, Not significant: p = n.s.

Values in parenthesis indicate percent increase (+) or decrease (-)

Table 7: Effect of *Cassia tora* seed extract on LDL : HDL ratio in rabbits

Treatment group	LDL : HDL Ratio		
	Initial	45th day	90th day
Normal Control	1.09 ± 0.04	1.21 ± 0.05	1.17 ± 0.12
Hyperlipidaemic Control	1.17 ± 0.08	2.48 ± 0.25*	3.40 ± 0.33*
Cassia tora	1.06 ± 0.11	2.40 ± 0.28 *n.s.*	2.74 ± 0.06 *n.s.*

Each value represents Mean ± SEM. (n=6)

Statistical comparison:

Hyperlipidaemic Control vs. Normal Control, *Cassia tora* vs. Hyperlipidaemic Control

Significance levels: $p < 0.05$ = *, Not significant: p = n.s.

Values in parenthesis indicate percent increase (+) or decrease (-)

Table 8: Effect of *Cassia tora* seed extract on liver, heart and fecal cholesterol content in rabbits.

Treatment group	Total cholesterol content liver (mg/ gm tissue)	Total cholesterol content in heart (mg/ gm tissue)	Total cholesterol in content faeces (mg/ gm)
Normal Control	8.93 ± 0.31	4.70 ± 0.16	36.73± 2.81
Hyperlipidaemic Control	14.76 ± 0.63*	8.26 ± 0.55*	123.95 ± 11.44*
Cassia tora	10.72 ± 1.07*	6.90 ± 0.39*	168.67 ± 10.21*

Each value represents Mean ± SEM. (n=6)

Statistical comparison:

Hyperlipidaemic Control vs. Normal Control, *Cassia tora* vs. Hyperlipidaemic Control

Significance levels: $p < 0.05$ = *, Not significant: p = n.s.

Values in parenthesis indicate percent increase (+) or decrease (-)

Discussion

The aim of present study was to assess the hypolipidemic activity of *Cassia tora* seed extract. Coronary heart disease (CHD) resulting from progressive atherosclerosis, remains the most common cause of morbidity and mortality all over the world (19). In developing countries, the incidence of cardiovascular disease is increasing alarmingly. India is on the verge of a cardiovascular epidemic (20,21).

Various epidemiological, animal and clinical studies clearly indicate that hypercholesterolemia, elevated low-density lipoprotein (LDL) and low high-density lipoprotein (HDL) are unequivocally linked to increased risk for coronary heart disease morbidity and mortality (4-6, 22-25).

Cholesterol feeding in rabbits caused a significant increase in the circulating total-cholesterol, LDL-cholesterol, VLDLcholesterol, and also in the ratios of total-cholesterol: HDL-cholesterol and LDLcholesterol: HDL-cholesterol. These results are consistent with earlier reports which have clearly established a correlation between dietary lipids and serum lipid profile (26,27). A significant increased in the ratios of total-cholesterol: HDL-cholesterol and LDL-cholesterol: HDL-cholesterol indicates increased risk of atherosclerosis and coronary heart disease.

LDL is one of the most powerful and independent risk factor for CHD. It has been demonstrated that every 1% decrease in LDL-cholesterol is associated with an approximate 1% decrease in CHD-related mortality (28). Simultaneous administration of *Cassia tora* seed extract caused a significant decrease ($p< 0.05$) in serum total cholesterol and LDL-cholesterol suggesting beneficial effect on cholesterol metabolism and turnover.

Elevated serum triglyceride is considered as independent risk factor for cardiovascular disease (29). Evidence of an inverse relationship between triglycerides and HDL-C suggests that both should be considered in CHD risk estimation and as targets for intervention (30). A significant ($p<0.05$) decline in the serum triglycerides level was observed in *Cassia tora* extract treated rabbits supports the cardiovascular protective influence. In present study, the decrease in serum triglyceride level may be due to increased catabolism of triglyceride. The decline in triglyceride levels could be attributed to the fiber content of *Cassia tora* seed extract. It is known that the dietary fibers decrease intestinal transit time for cholesterol and carbohydrate absorption leading to decreased hepatic lipogenesis and reduction in hepatic and serum triglyceride concentrations (31).

HDL are protective lipoproteins that decreases the risk of CHD thus, high levels of HDL are desirable. There is strong inverse correlation between HDL-cholesterol and CHD in both sexes. Framingham epidemiologic data suggest that a 1 mg/dL increase in HDL results in a 2% to 3% decrease in cardiac risk (32). In present study, a significant decrease ($p<0.05$) in HDL-cholesterol was observed. However, the possibility that feeding cholesterol powder in such a high concentration (400 mg/kg body weight/ day) to rabbits may have interfered in expressing the activity of the drug cannot be ruled out.

Total cholesterol content in liver and heart is a good indirect measure of atherosclerotic severity in cholesterol fed rabbits.Feeding of cholesterol rich diet to rabbits increases collagen biosynthesis and promotes accumulation of cholesterol in liver and heart. These results are supported by many earlier studies (33,34). The decrease in cholesterol level is suggestive of the beneficial role of plant products. Simultaneous administration of *Cassia tora* seed extract caused a significant ($P<0.05$) decline in the cholesterol contents of liver and heart indicating hypolipidemic effect.

The fractions of the seeds not extractable by alcohol have been shown to contain a considerable amount of soluble dietary fiber. The fiber has exhibited greater efficacy than guar gum and pectin in lowering blood lipids of rats fed high-cholesterol diets, with no detectable adverse effects (35). A significant ($P<0.05$) increase in cholesterol content of faeces was observed in *Cassia tora* seed extract treated group as compared to hyperlipidaemic control group after 90 days, indicating that the *Cassia tora* seed extract is possibly acting by this mode.

Conclusion

On the basis of present study, it is concluded that *Cassia tora* appears to be an effective plant material to provide hypolipidaemic effect. There was a significant increase in faecal cholesterol in *Cassia tora* seed extract treated group. The lipid lowering effect may be due to increased faecal excretion.

Acknowledgement

The authors are thankful to Emeritus Professor Dr. V N Sharma and Professor Rakesh Gupta, Principal, L.B.S. College of Pharmacy, Jaipur for valuable suggestions and providing the necessary facilities to carry out the present work.

References

1. Ghaffar A, Reddy K S and Singhi M. Burden of non-communicable diseases in South Asia. BMJ 2004; 328: 807-810.
2. Gupta R, Burden of coronary heart disease in India. Indian Heart J. 2005; 57: 632-8.
3. Yusuf S, Hawken S, Ounpuu S, et al. INTERHEART Study Investigators. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet 2004; 364:937-52.
4. Kannel W B, Castelli W P, Gordon T, et al. Serum cholesterol and the risk of CHD: The Framingham study. Ann. Intern. Med.1971; 74: 1-12.
5. Lipid Research Clinics Program. The Lipid Research Clinics Coronary Primary Prevention Trial results. II. The relationship of reduction in incidence of coronary heart disease to cholesterol lowering. JAMA 1984; 252: 2545-2548.
6. Brown M S & Goldstein J L. A receptor- mediated pathway for cholesterol homeostasis. Science 1986; 232: 34-47.
7. Mannienn V, Tenkanen L, Koskinen P, Huttunen J K Manttari M, et al. Joint effects of serum triglyceride and LDL cholesterol concentration of coronary heart disease risk in the Helsinki Heart Study. Implications for treatment. Circulation 1992; 85: 37-45.
8. Kwiterovich P O, Jr. State-of-the-art update and review: Clinical trials of lipid-lowering agents. Am J Cardiol 1998; 82: 3U–17U.
9. Annonymous. The Ayurvedic Pharmacopoeia of India. Part-I, 1st ed. Ministry of Health & Family Welfare, Govt. of India 1989 : 153-154.
10. Annonymous. Phytochemical Investigations of Certain Medicinal Plants Used in Ayurveda. Central Council for Research in ayurveda and Siddha, India 1990: 92-94.
11. Ghosh M N, Fundamentals of Experimental Pharmacology. Scientific Book Agency, Calcutta, Third Ed. 2005: 10-11.
12. Wybenga D R, Pileggi V J, Distine P H and Giorgio J D. Direct manual determination of serum total cholesterol with single stable reagent. Clin. Chem. 1970; 16: 980-984.
13. Scholnick,B.M. and Morfin, R. Cholesterol in high-density lipoprotein: Using Mg^{++} /PTA. J. Lipid. Res 1970; 19: 583-584.
14. Fossati P and Lerenzo P. Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. Clin. Chem. 1982; 28: 2077-2080.
15. McGowan M W, Artiss J D, Strandberg D R and Zak B A. Peroxidase coupled method for the colorimetric determination of serum triglycerides. Clin. Chem 1983; 29: 538-542.
16. Friedwald W T, Levy R I and Fredrickson D S. Estimation of concentration of low density lipoprotein cholesterol in the plasma without the use of preparative ultracentrifuge. Clin. Chem.1972; 18: 449-452.
17. Zlatkis A, Zak B and Boyal A J. A new method for direct determination of serum cholesterol. J. Lab. Clin. Med. 1953; 41: 486 - 489.
18. Folch J, Lees M and Staneley G H. A simple method for the isolation and purification of total lipids from animal tissues. Journal of Biological Chem. 1957; 497-509.
19. Yusuf S, Reddy S, Ounpuu S and Anand S. Global burden of cardiovascular diseases. Circulation 2001; 104: 2855-2864.
20. Grover A, Bahl A, Vijayavergiya R, et al. Changing trends of burden of cardiovascular disease in India. Implication for prevention based on 2001census. Ind. J.Cardiol. 2003; 6: 59-63.

21. Okirainec K, Banerjee D K and Eisenberg M J. Coronary artery disease in the developing world. Am. Heart J. 2004; 148: 7-15.
22. Stamler J, Wentworth D and Neaton J D. Is relationship between serum cholesterol and risk of premature death from coronary heart disease continuous and graded? Finding in 356,222 primary screenees of the Multiple Risk Factor Intervention Trial (MRFIT). JAMA 1986; 256: 2823-2828.
23. Braunwald E. Cholesterol and Recurrent Events Study. Presented at the American College of Cardiology 45th Annul Scientific Session; Orlando, March 1996; 24-26.
24. Lipid Study Group, Design features and baseline characteristics of the LIPID (long-term intervention with pravastatin in ischaemic disease) study: A randomized trial in patients with previous acute myocardial information and / or unstable angina pectoris. Am. J. Cardiol. 1995; 76: 474-479.
25. NCEP. Adult Treatment panel III Executive summary of the third report of the National Cholesterol Education Program of high blood cholesterol in adult. J Am Med Assoc; 2001; 285: 2486-97.
26. Vijaimohan K, Jainu M, Sabitha K E, et al. Beneficial effects of alpha linolenic acid rich flax seed oil on growth performance and hepatic cholesterol metabolism in high fat diet fed rat. Life Sci. 2006; 79: 448-454.
27. Daniela CU, Raquel B, Laura Q B, et al. Effects of probiotic bacteria, isoflavones and simvastatin on lipid profile and atherosclerosis in cholesterol-fed rabbits: a randomized double-blind study. Lipids in Health and Disease 2009; **8**:1
28. Scandinavian Simvastatin Survival Study Group. Randomised trial of cholesterol lowering in 4444 patients with coronary heart disease: the Scandinavian Simvastatin Survival Study (4S). Lancet 1994; 344: 1383–1389
29. Asia Pacific Cohort Studies collaboration, Serum triglycerides as risk factor for cardiovascular disease in the Asia Pacific Region. Circulation 2004; 110: 2678-2686.
30. Morrison A and Hokanson J E, The independent relationship between triglycerides and coronary heart disease. Vascular Health and Risk Management. 2009; 5: 89–95
31. Seyed Ali, Bagher Z, Shahin L, et al. Psyllium decreased serum glucose and glycosylated haemoglobin significantly in diabetic outpatients. Journal of Ethnopharmacology 2005; 102(2): 202-207.
32. Schaefer E J, Lamon-Fava S, Ordovas J M, et al. Factors associated with low and elevated plasma high density lipoprotein cholesterol and apolipoprotein A-1 levels in the Framingham offspring study. J. Lipid Res 1995; 35: 8-9.
33. Mehta K, Balaraman R, Aminb A H, et al. Effect of fruits of *Moringa oleifera* on the lipid profile of normal and hypercholesterolaemic rabbits. Journal of Ethnopharmacology 2003; 86 (2-3): 191-195.
34. Purohit A and Vyas K B, Antiatherosclerotic efficacy of *Capparis decidua* shoot extract (50% EtOH) in hyperlipidaemic rabbits. Indian Drugs 2005; 43 (10): 807-812.

35. Korea Food Research Institute, Seoul, Korea, A Study on New Product Development with *Cassia tora* L. Seed for Functional Food (Final Report for Agriculture R & D Promotion Center; Project Number GA 0353-226) 2002.