CHAPTER 8

Antihyperlipidemic Activities of Medicinal Plants in Triton wr-1339 Induced Hyperlipidemic Rats
8.1 INTRODUCTION

Cardiovascular disease is a major cause of morbidity and mortality all over the world (WHO, 2000). It is well established that elevated levels of plasma cholesterol or more specifically plasma low density lipoprotein cholesterol (LDL-c) is regarded as a crucial risk factor in the prevalence of atherosclerosis (National Cholesterol Education Program, 2001). Lowering of elevated levels of total cholesterol (Tc) and low density lipoprotein cholesterol reduces the risk of cardiovascular disease (Lipid Study Group, 1998). On the other hand a strong inverse relation between HDL-cholesterol (HDL-c) and risk of coronary heart disease has been advocated (Stein and Stein, 1999). The modulation of risk of coronary heart disease by lowering blood lipid profiles by using natural products of plant origin as a possible therapeutic measure has become a subject of active scientific investigation. Medicinal plants are important source of a large number of active novel compounds, which offer themselves as promising substances for the development of hypolipidemic and antioxidant agent (Haber 2001; Anilla and Vijaylakshmi, 2002).

*Cassia fistula* Linn., commonly known as Indian laburnum has been used in the treatment of various ailments dating back to ‘Charak Samhita’ and ‘Sushrut Samhita’. According to Ayurvedic and Unani systems of medicines, various parts of *C. fistula* are highly useful in curing various diseases viz. cardiac disorders, diabetes, skin diseases and snakebite (Kirtikar and Basu, 2006). The pulp from the pod is of great therapeutic value, it is a mild, pleasant and safe purgative, even for children and expectant mothers. Experimental studies have shown that extract of *C. fistula* possesses hypolipidemic (el-Saadany *et al.*, 1991), hepatoprotective (Bhakta *et al.*, 2001), antibacterial and antifungal (Duraispandivan and Ignacimuthu, 2007) activities. Extensive studies have been carried out during the past few decades for isolation and characterisation of chemical constituents of various parts of *C. fistula*. Lal and Gupta (1972) isolated rhein, glucose, sucrose and fructose from the fruit pulp and galactomannans from the seeds of the *C. fistula*. Agrawal *et al* (1972) isolated fistulic acid from the pods, and kaempferol and a leucopelargonidin tetramer having free glycol unit from the flowers. The pulp is rich source of minerals and energy and contains a large number of essential amino acids in good amount (Barthakur, 1995). Kuo *et al* (2002) have isolated and identified oxyanthraquinones, chrysophanol and chrysophanein from the seeds of *C. fistula*. Nirmala *et al* (2008) studied effect of Hexane...
extract of *Cassia fistula* Bark on Blood Glucose and Lipid Profile in streptozotocin diabetic rats.

From the beginning of the last century, evidences on the cholesterol-lowering properties of medicinal plants have been accumulating. The importance of such investigations, are confirmed in the treatment of obesity, diabetes mellitus, heart failure, and atherosclerosis. Scientists have reported the role of medicinal plants in the control of elevated serum cholesterol, and the reduction of morbidity and mortality due to vascular diseases associated with it. Coronary artery disease (CAD) is one of the most important causes of death all over the world. According to World Health Organization (WHO), by 2020, Asian Indians will represent 50-60% of the world’s cardiac patients, which amounts to about 100 million patients. High plasma level of cholesterol increases generation of reactive species (ROS) that play key role in the development of coronary artery disease (CAD) and atherosclerosis (Kaesancini and Krauss, 1994; Sing et al, 2007).

*Aegle marmelos* is a traditional medicinal plant and the root of this plant is sweet; cures fever, pain in the abdomen, palpitation of the heart, urinary problems. The leaves are astringent, digestive; laxative, when fresh; the flowers allay thirst and vomiting; useful in dysentery. The ripe fruit is a restorative tonic, astringent, laxative; good for the heart and brain. Recent study has shown that intake of extract of this medicinal plant by experimental rats results in an increase of antioxidant enzymes activity and HDL cholesterol, and a decrease in malondialdehyde, which may reduce the risk of heart disease (Devi et al, 2010). *A. marmelos* is being widely used to treat diabetes by the traditional practitioners over many centuries. Aqueous fruit extract reduced the blood glucose levels (Kesari et al, 2006) and aqueous leaf extract significantly controlled blood glucose, urea, body weight, liver glycogen and serum cholesterol (Grover et al., 2002). It also showed histo-pathological alterations in the pancreatic, liver and the kidney tissues indicating the potential of hypoglycemic nature of the extract (Das et al., 1996 ); the methanolic leaf extract elucidated as a effective used for hypoglycemic and antioxidant activity (Sabu and Kuttan, 2004, Upadhya et al., 2004); the fruit extract improved functional state of pancreatic β-cells and partially reversed the damage (Kamalakannan and Mainzen, 2005).
Psida (Sida) cordifolia Linn. is found in the Indian system of medicine (Ayurveda) and is known as bala (Dhalwal et al., 2005). The aqueous extract of whole plant of S. cordifolia was reported to possess hepatoprotective activity against carbon tetrachloride, paracetamol, and rifampicin-induced hepatotoxicity (Kotoky and Das, 2000). The compound sitoindoside X, an acylsterylglycoside, isolated from the roots of Sida cordifolia has been proved as an adaptogenic and immunostimulant (Ghosal et al., 1988).

However, there is scarcity of literature on antihyperlipidemic activity of Cassia fistula, Psida cordifolia, and Aegel marmelos in triton wr-1339 induced hyperlipidemic rats on individual as well as different proportion of combinations of ethanolic leaf extract. The present study was designed to test the efficacy of ethanolic leaf extract of these plants on serum lipid profile changes associated with hyperlipidemia in experimental rats. The biopotential of plant extract with multiple combinations are to be assessed for synergistic actions.

8.2 MATERIALS AND METHOD

Studies of anti-hyperlipidemic activity of Aegel marmelos Cassia fistula and Psida cordifolia was carried out in following ways:

a) Collection of plant material and preparation of plant extract:

The leaves of Cassia fistula, Psida cordifolia, and Aegel marmelos were collected and processed as per discription given in Chapter 7.2. The plant material was dried in shade and ground to coarse powder and extracted with 50% ethanol for 36 hours at 60-80 °C. The extract was filtered and evaporated to dryness under low temperature and reduced pressure. The crude extract so obtained was suspended in double distilled water and used for experimental study.

b) Animal used:

Adult male Wistar rats weighing around 180-200g were purchased from Wockhardt Research Laboratory, Aurangabad, MS, India. The animals were kept in polypropylene cages (three in each cage) at an ambient temperature of 25±2°C and 55-65% relative humidity 12±1 hr light and dark schedule was maintained in the animal house till the animals were acclimatized to the laboratory conditions, and were fed with commercially...
available rat chow (Hindustan Lever Ltd., Bangalore, India) and had free access to water. The experiments were designed and conducted in accordance with the guidelines of institutional animal ethical committee of College of Pharmacy, Chopda Dist. Jalgaon.MS.

c) Chemicals
Triton WR-1335 (a non-ionic detergent, iso octyl polyoxy ethylene phenol, formaldehyde polymer) and all other analytical chemicals including standard antilipidemic drug Fenofibrate were obtained from Himedia, Mumbai.

d) Collection of blood:
On the 8th day, blood was collected by retero orbital sinus puncture, under mild ether anaesthesia. The collected samples were centrifuged for 10 minutes. Then serum samples were collected and used for various biochemical experiments.

e) Biochemical analysis:
The serum was assayed for total cholesterol, triglycerides, phospholipids, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very low-density lipoprotein (VLDL) using standard protocol methods (Burstein and Scholnick, 1972).

ESTIMATION OF LIPID PROFILE
The levels of cholesterol, triglycerides, free fatty acids and phospholipids were estimated in the serum samples. The kits used for these assays were purchased from Span Diagnostics Ltd., Surat, Gujrat, India.

ESTIMATION OF CHOLESTEROL

PRINCIPLE
Cholesterol esters are hydrolysed to cholesterol and fatty acids. The cholesterol is oxidized by cholesterol oxidase to form cholesten-3-one and H2O2. This H2O2 oxidizes 4-amino antipyrene and phenol to a red coloured compound, which can be measured at 505nm.

REAGENTS
1. Reagent 1
   1. Buffer (50 mmol/L pH 6.7)
   2. Cholesterol oxidase ³ 50 IU/L
   3. Cholesterol esterase ³ 100 IU/L
4. Peroxidase ³ 3 IU/L
5. 4-amino antipyrine (0.4 mmol/L)

2. Reagent 2
Cholesterol standard (200 mg/dL)

PROCEDURE
To 1.0 ml of cholesterol reagent, 10µl of serum and standards were added separately. The contents were mixed well and incubated at 37°C for 10 minutes. The absorbance of the standard and sample was measured against reagent blank at 505nm within 60 minutes. The serum cholesterol is expressed as mg/dl.

ESTIMATION OF TRIGLYCERIDES

PRINCIPLE
Triglycerides are hydrolysed by lipases to glycerol and free fatty acids. Glycerol is converted to H₂O₂ and dehydroxyacetone phosphate. H₂O₂ combines with 4-chlorophenol to form a pink coloured complex, whose absorbance is measured at 500nm.

REAGENTS
1. Buffer  Magnesium chloride 9.8 mmol/L
   PIPES 100 mmol/L
   Chloro-4-phenol 3.5 mmol/L
2. Enzymes  Lipase ≥ 1000 IU/L
   Peroxidase ≥ 1700 IU/L
   Glycerol 3 phosphate oxidase ≥ 3000 IU/L
   Glycerol kinase ≥ 600 IU/L
3. 4-amino-antipyrine (PAP) 0.5 mmol/L
4. Adenosine triphosphate Na (ATP) 1.3 mmol/L
5. Standard  Glycerol 2.8 mmol/L
   Triglycerides 200 mg/dL

PROCEDURE
To three tubes, namely blank, calibrator and assay tubes, 300 µl of buffer was added and 3µl of sample was added only to the assay tube. The contents were mixed vigorously and allowed to stand for 10 minutes at 37°C. The absorbance was recorded at 546nm in a spectrophotometer (BioEra, Pune) against blank. The values are expressed as mg/dL.
ESTIMATION OF PHOSPHOLIPIDS

PRINCIPLE
Phospholipids are digested with sulphuric acid and the inorganic phosphorus formed reacts with ammonium molybdate and aminonaphthol sulphonic acid (ANSA) to form a blue colour, which is measured at 680 nm.

REAGENTS
1. Sulphuric acid (5N)
2. Concentrated HNO₃
3. Ammonium molybdate (2.5%)
4. ANSA (0.1%)
5. Standard phosphate (KH₂PO₄ to give a final concentration of 8µg of phosphorus per ml)

PROCEDURE
To 0.1ml of serum, 1.0ml of 5N H₂SO₄ was added and digested in a digestion flask until a light brown colour was formed. Concentrated HNO₃ (2-3 drops) was added and digested until the solution became colourless. Then 1.0ml of water was added and heated in a boiling water bath for 5 minutes. It was followed by 1.0ml of ammonium molybdate and 0.1ml of ANSA and the volume was made up to 10ml with distilled water. Standards were also treated similarly and the absorbance was measured at 680nm in a spectrophotometer (BioEra, Pune) within 10 minutes. The serum phospholipids are expressed as mg/dL.

f) Experimental design for antihyperlipidemic studies:
The studies were conducted in the ten groups of six rats in each.

Group I: Rats fed on normal pallet diet and distilled water (0.5ml/rat) as vehicle

Group II: triton wr-1339 induced hyperlipidemic rats (Experimental)

Group III: triton wr-1339 induced hyperlipidemic rats fed with extract of A.marmelos

Group IV: triton wr-1339 induced hyperlipidemic rats fed with extract of C.fistula

Group V: triton wr-1339 induced hyperlipidemic rats fed with extract of P.cardifolia
Group VI: triton wr-1339 induced hyperlipidemic rats fed with mixture of extracts from *A.marmelos* and *C.fistula*

Group VII: triton wr-1339 induced hyperlipidemic rats fed with mixture of extracts from *A.marmelos* and *P.cardifolia*

Group VIII: triton wr-1339 induced hyperlipidemic rats fed with extract of mixture of extracts from *C.fistula* and *P.cardifolia*

Group IX: triton wr-1339 induced hyperlipidemic rats fed with extract of mixture of extracts from *A.marmelos* *C.fistula*, and *P.cardifolia*.

Group IX: triton wr-1339 induced hyperlipidemic rats administered Fenofibrate (a standard antilipidemic drug at a dose of 100 mg/kg of body wt.)

Rats were given a dose of 400 mg/kg of triton to induce hyperlipidemia in experimental rats. The hyperlipidemic rats of all groups were fed with plant extract in dosages of 150 mg/kg body weight to assess therapeutic effect of the extracts. Separate batches were maintained in each group for each dose level.

g) Statistical analysis:

Estimated values expressed as mean ± SEM from 6 observations. Statistical analysis was carried out by using ANOVA followed by Dunnet’s multiple comparison tests using Graph pad PRISM software version 6.04 (2014). The values of P< 0.001 and P< 0.05 were considered as statistically significant.

8.3 RESULT

Individual and combined concentration of aqueous and ethanolic leaf extracts of *Cassia fistula*, *Psida cordifolia*, and *Aegel marmelos* were evaluated for their hypolipidemic activity in experimental rats, which were treated with triton wr-1339 to induce hyperlipidemic condition. Table 8.1 displays the effects of aqueous and ethanolic leaf extract of *A.marmelos*, *C.fistula* and *P.cardifolia* on serum HDL, LDL and VLDL in hyperlipidemic rats. The serum level of HDL in rats of group III (treated with triton wr-1339 and fed with extract of *A.marmelos*) showed highly significant (P<0.001) increase with 72% change over its normal value due to its methanolic nature and 60% increase over its normal value due to its aqueous nature, this change was significant at P<0.05.
Highly significant rise in serum HDL (P<0.001) was noted in rats of group VI (triton wr-1339 induced hyperlipidemic rats fed with mixture of ethanolic leaves extracts from *A.marmelos* and *C.fistula*) with 99% change over its normal value. It was then followed by the rats of group IX, which were triton wr-1339 induced hyperlipidemic rats fed with the mixture of ethanolic leaves extracts from all three plants. The serum HDL showed 87% increase over its normal value (P<0.001). Comparatively, the mixture of ethanolic leaves extract of *A.marmelos* and *C.fistula* showed highly potent antilipidemic activity since increase in serum high-density lipoprotein (HDL) indicated a reversed atherogenic risk.

Table 8.1 Effect of aqueous and ethanolic leaf extract of *A.marmelos, C.fistula* and *P.cardifolia* on serum HDL, LDL and VLDL in hyperlipidemic rats.

<table>
<thead>
<tr>
<th>Group</th>
<th>HDL (mg/dl)</th>
<th>LDL (mg/dl)</th>
<th>VLDL (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AE</td>
<td>EE</td>
<td>AE</td>
</tr>
<tr>
<td>I</td>
<td>24.07±1.2</td>
<td></td>
<td>25.79±1.4</td>
</tr>
<tr>
<td>II</td>
<td>17.15±0.9</td>
<td>(-29%)*</td>
<td>142.57±12.5</td>
</tr>
<tr>
<td>III</td>
<td>27.52±1.4</td>
<td>(+60 %)**</td>
<td>79.22±1.4</td>
</tr>
<tr>
<td></td>
<td>29.36±1.2</td>
<td>(+72%)**</td>
<td>73.46±1.8</td>
</tr>
<tr>
<td>IV</td>
<td>26.44±1.1</td>
<td>(+54%)**</td>
<td>89.35±1.3</td>
</tr>
<tr>
<td></td>
<td>28.12±1.4</td>
<td>(+63%)**</td>
<td>73.46±1.8</td>
</tr>
<tr>
<td>V</td>
<td>25.19±0.6</td>
<td>(+47%)**</td>
<td>94.68±1.5</td>
</tr>
<tr>
<td></td>
<td>26.19±0.5</td>
<td>(+53%)**</td>
<td>80.33±1.4</td>
</tr>
<tr>
<td>VI</td>
<td>29.78±0.5</td>
<td>(+74%)**</td>
<td>69.79±1.3</td>
</tr>
<tr>
<td></td>
<td>34.15±1.4</td>
<td>(+99%)**</td>
<td>57.35±1.2</td>
</tr>
<tr>
<td>VII</td>
<td>26.55±0.6</td>
<td>(+55%)**</td>
<td>73.44±0.9</td>
</tr>
<tr>
<td></td>
<td>28.19±0.7</td>
<td>(+64%)**</td>
<td>72.56±2.4</td>
</tr>
<tr>
<td>VIII</td>
<td>26.14±0.3</td>
<td>(+52%)**</td>
<td>74.33±1.4</td>
</tr>
<tr>
<td></td>
<td>29.13±0.6</td>
<td>(+70%)**</td>
<td>73.18±1.2</td>
</tr>
<tr>
<td>IX</td>
<td>28.34±0.6</td>
<td>(+65%)**</td>
<td>78.26±2.5</td>
</tr>
<tr>
<td></td>
<td>32.14±0.8</td>
<td>(+87%)**</td>
<td>69.25±0.8</td>
</tr>
<tr>
<td>X</td>
<td>34.14±1.4</td>
<td>(+99%)**</td>
<td>84.22±0.8</td>
</tr>
</tbody>
</table>

Each value is Mean±SD of six observations.*Values in paranthesis are % changes of II vs I.*

**Values in paranthesis are % changes of III to X vs II.

AE(Aqueous Extract), EE (Ethanolic Extract).

The serum low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) showed reverse trend in its values in experimental rats than compared with normal rats. The ethanolic leaf extracts of all three plants were more potent than that of aqueous extracts. The highest hypolipidemic activity was shown by the rats of group III, followed...
by VI and then IX with 62% (P<0.001), 60% (P<0.001) and 52% (P<0.05) respectively reduction in serum LDL of experimental rats under the impact of ethanolic leaves extract of *A. marmelos* (group III), mixture of ethanolic leaves extracts of *A. marmelos* and *C. fistula* (group VI) and mixture of ethanolic leaves extracts of all three plants. Similar trend of reduction in serum VLDL was noted in experimental rats of group III (43% significant reduction at P<0.001), followed by VI (35% significant reduction at P<0.05) and then IX (32% significant reduction at P<0.05).

An effect of aqueous and ethanolic leaves extracts on serum Cholesterol, Triglycerides, Phospholipids in hyperlipidemic rats on the individual and combined basis is given in table 8.2. The aqueous leaf extracts of all three plants showed less hypolipidemic potency than that of ethanolic leaf extracts in experimental rats.

Table 8.2 Effect of aqueous and ethanolic leaf extract of *A. marmelos*, *C. fistula* and *P. cardifolia* on serum Cholesterol, Triglycerides, Phospholipids in hyperlipidemic rats.

<table>
<thead>
<tr>
<th>Group</th>
<th>Cholesterol (mg/dl)</th>
<th>Triglycerides (mg/dl)</th>
<th>Phospholipids (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AE</td>
<td>EE</td>
<td>AE</td>
</tr>
<tr>
<td>I</td>
<td>68.23±2.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>132.72±12.4 (+94%)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>79.65±1.6 (-40%**)</td>
<td>62.5±0.9 (-53%**)</td>
<td>72.13±1.2 (-41%**)</td>
</tr>
<tr>
<td>IV</td>
<td>86.21±1.3 (-36%**)</td>
<td>77.32±1.2 (-42%**)</td>
<td>78.75±0.9 (-34%**)</td>
</tr>
<tr>
<td>V</td>
<td>89.98±1.2 (-33%**)</td>
<td>81.32±0.7 (-39%**)</td>
<td>83.33±1.1 (-33%**)</td>
</tr>
<tr>
<td>VI</td>
<td>72.08±1.3 (-41%**)</td>
<td>60.43±0.6 (-55%**)</td>
<td>68.38±1.6 (-42%**)</td>
</tr>
<tr>
<td>VII</td>
<td>90.32±2.4 (-32%**)</td>
<td>82.22±1.2 (-38%**)</td>
<td>70.32±1.4 (-41%**)</td>
</tr>
<tr>
<td>VIII</td>
<td>87.12±1.6 (-36%**)</td>
<td>75.01±0.9 (-44%**)</td>
<td>76.14±1.7 (-36%**)</td>
</tr>
<tr>
<td>IX</td>
<td>72.12±0.7 (-46%**)</td>
<td>65.08±1.3 (-51%**)</td>
<td>75.07±1.3 (-37%**)</td>
</tr>
<tr>
<td>X</td>
<td>76.88±2.3 (-42%**)</td>
<td></td>
<td>78.67±1.5 (-34%**)</td>
</tr>
</tbody>
</table>

Each value is Mean±SD of six observations.*Values in paranthesis are % changes of II vs I. **Values in paranthesis are % changes of III to X vs II. AE(Aqueous Extract), EE (Ethanolic Extract).

The normal serum cholesterol was 68.23±2.4 mg/dl in rats of group I. It was then boosted to 132.72±12.4 mg/dl in group II rats. Highly significant hypolipidemic effect was
executed by mixture of ethanolic leaves extract of *A.marmelos* and *C.fistula* in rats of
group VI (55% significant reduced value at P<0.001), followed by rats (of group III)
treated with triton wr-1339 induced hyperlipidemic rats fed with extract of *A.marmelos*
(53% significant reduced value at P<0.001) and then by the hyperlipidemic rats of group
IX fed with ethanolic leaves extract of all three plants (51% significant reduced value at
P<0.001). Similar reducing trend was noted in serum triglyceride of experimental rats
with 55% reduction in rats of group VI, followed by 48% reduction in rats of group III
and then 45% reduction in rats of group IX. The highest reduction (40%, significant at
P<0.001) in serum phospholipid was noted in rats of group III under the implact of
ethanolic leaves extract of *A.marmelos*, followed by group VI rats with 38% reduction
(P<0.05) and then by group IX rats with 36% reduction (P<0.05) over its value in
hyperlipidemic stage.

8.4 Discussion

Several studies reveal that an increase in HDL and decrease in TC, LDL cholesterol and
TG is associated with a decrease in the risk of ischemic heart diseases (Stein and Stein,
1999; Visavadiya and Narasimhacharya, 2005; Singh et al, 2007). Most of the
antihyperlipidemic drugs are causing significant reduction in both TC and HDL
cholesterol levels (Saravanan et al, 2007). Triton Wr-1339 has been widely used to block
clearance of triglyceride-rich lipoproteins to induce acute hyperlipidemia in several
animals (Jeyabalan and Palayan, 2009). This model is widely used for a number of
different aims particularly, in rats it has been used for screening natural or chemical
hypolipidemic drugs (Gupta and Jain, 2006 and 2009). Interestingly, the results of the
present study show that ethanolic leaves extracts of *A.marmelos*, *C.fistula* and
*P.cardifolia* produced a significant reduction in cholesterol level and also it reversed
Triton induced hypolipidemic in rats. Schurr et al (1972) demonstrated for the first time
that oral administration of a dose of TritonWr-1339 to adult rats induced hyperlipidemia.
The present study clearly show that ethanolic leaves extract of *A.marmelos* on individual
basis, followed by mixture of *A.marmelos* and *C.fistula* and then mixture of ethanolic
leaves extracts of all three plants at a dose of 150mg/kg significantly lowered both
plasma triglycerides and cholesterol levels. The large increase in plasma cholesterol and
triglycerides due to Triton Wr-1339 injection results mostly from an increase of VLDL
secretion by the liver accompanied by a strong reduction of VLDL and LDL catabolism (Otway and Robinson, 1967).

The reduction of total cholesterol by the *Sesbania grandiflora* extract was associated with a decrease of its LDL fraction, which is the target of several hypolipidemic drugs. This result suggests that cholesterol-lowering activity of the herb extract can be result from the rapid catabolism of LDL cholesterol through its hepatic receptors for final elimination in the form of bile acids as demonstrated by Khanna et al (2002).

In the fact, flavonoids and anthocyanins, a heterogeneous group of ubiquitous plant polyphenols, have exhibited a variety of pharmacological activities, including the anti-atherogenesis and antioxidant effect (Del et al, 2005). Furthermore, quantification of tannins, proanthocyanidins and flavonoids contents in plant samples confirmed the results reported by Devi et al (2010) showing that these phenolic fractions represent major compounds of *A. marmelos* leaves. Gupta and Jain (2009) also supported these finding by studying hypolipidemic activity of *Cassia fistula*. The results strongly suggest that the hypolipidemic activity of these medicinal plants could be attributed to the presence of the valuable polyphenolic compounds that may reduce the activity of cholesterol biosynthesis enzymes and / or low-level lipolysis.

8.5 CONCLUSION

Based on the aforementioned results, it is concluded that ethanolic extract of *A. amrmelos* and *C. fistula* leaves and to some extent of *P. caridfolia* have beneficial effects on lipolysis as well as improving hypolipidemic and other metabolic aberrations as they casued to decrease serum LDL, VLDL, Cholesterol, Triglycerides and phospholipids in hyperlipidemic rats. Therefore, *A. amrmelos* and *C. fistula* leaves and to some extent of *P. caridfolia* are considered to be effective and alternative treatment for hyperlipidemic disorder. Further phytochemical and pharmacological investigations will clearly elucidate the specific phytoconstituents and mechanism of action responsible for such an effect and will be helpful in projecting these plants as a therapeutic target for disorders in lipid metabolism noted in hyperlipidemic state.