4. RESULTS

The results of various experiments carried on the different extracts of *Murraya koenigii* leaf are reported here.

4.1 EXPERIMENT-I

In this experiment aqueous, chloroform, methanol and ether leaf extracts of *Murraya koenigii* were evaluated for their antidiabetic activity in Alloxan-Diabetic Wister albino rats. Each extract was tested at two doses viz. 100 and 1000 mg/kg b.w. for a period of 8 weeks. The plasma glucose and insulin levels were measured at the weekly interval and results were compared with the diabetic control (DC) group.

4.1.1 Antidiabetic activity

4.1.1a Plasma glucose

The effect of administration of aqueous, chloroform, methanol and ether leaf extracts of *Murraya koenigii* on plasma glucose concentration in rats are presented in Table 1 and graphically depicted in Fig. 1. There was a significant decrease in plasma glucose concentrations in the groups administered with aqueous (A2) and methanol extract (M2) at the dose of 1000 mg/kg b.w., as compared to plasma glucose concentrations of control group (DC) on respective days. In A2 group there was a significant decrease (P<0.05) in the plasma glucose levels from Day 28 onwards, 224.6±19.6 mg/dl on Day 28, 216.9±20.4 mg/dl on Day 35, 198.7±17.5 mg/dl on Day 42, 187.9±19.7 mg/dl on Day 49 and 179.8±21.5 mg/dl on day 56 of the experiment. M2 group showed the significant decrease (P<0.05) in the plasma glucose concentration on Day 35 onwards, 222.7±18.4 mg/dl on Day 35, 202.6±23.6 mg/dl on Day 42, 196.7±25.4 mg/dl on Day 49 and 181.6±24.3 mg/dl on Day 56 of the experiment.

4.1.1b Plasma Insulin

The effect of administration of aqueous, chloroform, methanol and ether leaf extracts of *Murraya koenigii* on plasma insulin concentration in rats are presented in
Table 2 and graphically depicted in Fig. 2. There was a significant increase (P<0.05) in plasma insulin concentrations in the groups administered with aqueous (A2) and methanol extract (M2) at the dose of 1000 mg/kg b.w., as compared to plasma insulin concentrations of control group (DC) on respective Days. A2 group showed a significant increase in the plasma insulin levels from Day 35 onwards 22.85±0.76 μU/ml on Day 35, 23.58±1.08 μU/ml on Day 42, 25.36±1.18 μU/ml on Day 49 and 27.48±0.97 μU/ml on Day 56 of the experiment. M2 group showed a significant increase in plasma insulin concentration from Day 35, 22.84±1.18 μU/ml on Day 35, 24.36±1.11 μU/ml on Day 42, 26.65±0.87 μU/ml on Day 49 and 28.48±0.76 μU/ml on Day 56 of the experiment.

4.2 EXPERIMENT- II

Based on the results of the experiment-I, Aqueous and methanol leaf extracts of *Murraya koenigii* that showed promising antidiabetic activity were considered for experiment-II. These extracts were evaluated for their antidiabetic, hypolipidemic and antioxidant activity in Alloxan-Diabetic Wistar albino rats. Each extract was tested at three doses viz. 200, 400 and 800 mg/kg b.w., for a period of 12 weeks. Oral hypoglycemic drugs Glibenclamide 0.25mg/kg b.w. and Metformin 10mg/kg b.w. were used as positive control.

4.2.1 Antidiabetic activity

4.2.1a Plasma glucose

Aqueous extract and Methanol extract of *Murraya koenigii* significantly reduced (P<0.05) the plasma glucose levels in the groups administered at the dose of 400 mg/kg b.w and 800 mg /kg b.w. The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on plasma glucose concentration
in rats are presented in Table 3 and graphically depicted in Fig. 3. The plasma glucose levels in the diabetic control group (DC) was 289.25±14.69 mg/dl on Day 0, 284.38±15.78 mg/dl on Day 15, 286.38±19.34 mg/dl on Day 30, 284.64±18.61 mg/dl on Day 45, 278.39±16.27 mg/dl on Day 60, 280.49±20 mg/dl on Day 75 and 276.21±19.07 mg/dl on Day 90. Compared to corresponding plasma glucose levels of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) showed significant decrease in plasma glucose levels from Day 45 onwards 209.37±20.06 mg/dl on Day 45, 186.34±19.34 mg/dl Day 60, 173.35±19.64 mg/dl Day 75, and 162.54±17.57 mg/dl Day 90. Metformin (10 mg/kg b.w.) administered group (DME) showed significant decrease in plasma glucose levels from Day 75 onwards 199.38±17.45 mg/dl on Day 75, 181.37±18.71 mg/dl on Day 90. DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. did not show significant change in plasma glucose levels. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in plasma glucose levels from Day 75 onwards 202.47±15.15 mg/dl on Day 75, 186.29±20.08 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in plasma glucose levels from Day 60 onwards, 202.38±19.08 mg/dl on Day 60, 172.31±17.60 mg/dl on Day 75 and 164.39±19.34 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. did not show significant change in plasma glucose levels. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in plasma glucose levels from Day 75 onwards, 201.48±15.29 mg/dl on Day 75 and 184.61±17.51 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in plasma glucose levels from
Day 60 onwards, 198.54±15.86 mg/dl on Day 60, 176.60±17.59 mg/dl on Day 75 and 160.07±16.27 mg/dl on Day 90.

4.2.1b Plasma Insulin

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on plasma insulin concentration in rats are presented in Table 4 and graphically depicted in Fig. 4. The plasma insulin levels in the diabetic control group (DC) was 18.37±0.64 μU/ml on Day 0, 17.56±0.81 μU/ml on Day 15, 18.64±0.57 μU/ml on Day 30, 19.76±0.69 μU/ml on Day 45, 19.29±0.76 μU/ml on Day 60, 20.84±0.72 μU/ml on Day 75 and 21.08±0.91 μU/ml on Day 90. Compared to corresponding plasma insulin levels of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) showed significant increase in plasma insulin levels from Day 15 onwards, 24.67±0.86 μU/ml on Day 15, 28.67±0.91 μU/ml on Day 30, 31.64±0.99 μU/ml on Day 45, 33.61±1.18 μU/ml on Day 60, 30.08±1.37 μU/ml on Day 75, 29.31±1.67 μU/ml on Day 90. Metformin (10 mg/kg b.w.) administered group (DME) did not show a significant change in the plasma insulin levels during 90 Days study.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. did not show a significant change in plasma insulin levels during 90 Days study. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant increase in plasma insulin levels from Day 60 onwards, 24.97±1.65 μU/ml on Day 60, 28.13±1.28 μU/ml on Day 75 and 29.31±1.71 μU/ml on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant increase in plasma insulin levels from Day 30 onwards, 25.39±0.89 μU/ml
on Day 30, 28.74±1.31 μU/ml on Day 45, 32.76±1.34 μU/ml on Day 60, 35.18±1.28 μU/ml on Day 75 and 36.74±1.42 μU/ml on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant increase in plasma insulin levels from Day 60 onwards, 24.18±1.28 μU/ml on Day 60, 24.69±1.31 μU/ml on Day 75 and 26.18±1.52 μU/ml on Day 90. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant increase in plasma insulin levels from Day 60 onwards, 26.31±1.34 μU/ml on Day 60, 27.88±1.16 μU/ml on Day 75 and 31.34±1.48 μU/ml on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant increase in plasma insulin levels from Day 30 onwards, 25.67±1.48 μU/ml on Day 30, 29.34±1.64 μU/ml on Day 45, 32.15±1.29 μU/ml on Day 60, 36.28±1.46 μU/ml on Day 75 and 38.17±1.62 μU/ml on Day 90.

4.2.2 Hypolipidemic activity
4.2.2a Serum Total cholesterol

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum total cholesterol concentration in rats are presented in Table 5 and graphically depicted in Fig. 5. The serum total cholesterol concentration in the diabetic control group (DC) was 112.15±4.38 mg/dl on Day 0, 125.41±4.91 mg/dl on Day 15, 133.27±5.59 mg/dl on Day 30, 152.85±5.76 mg/dl on Day 45, 148.67±4.88 mg/dl on Day 60, 157.36±5.47 mg/dl on Day 75 and 161.97±6.11 mg/dl on Day 90. Compared to serum total cholesterol concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant change serum total cholesterol concentration during 90 days of experiment. Metformin (10 mg/kg b.w.) administered group (DME) showed a significant decrease in the serum total cholesterol from Day
30 onwards, 119.34±5.15 mg/dl on Day 30, 126.53±5.67 mg/dl on Day 45, 129.84±5.42 mg/dl on Day 60, 132.37±4.99 mg/dl on Day 75 and 136.18±5.17 mg/dl on Day 90.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. showed a significant decrease in the serum total cholesterol on Day 75, 141.62±5.82 mg/dl. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the serum cholesterol levels from Day 60 onwards, 124.57±5.65 mg/dl on Day 60, 119.47±5.47 mg/dl on Day 75 and 111.54±6.28 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the serum cholesterol levels from Day 30 onwards, 108.82±8.91 mg/dl on Day 30, 101.24±6.21 mg/dl on Day 45, 99.34±6.75 mg/dl on Day 60 and 92.91±5.93 mg/dl on Day 75 and 90.09±6.27 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant decrease in serum cholesterol levels from Day 60 onwards, 132.24±5.13 mg/dl on Day 60, 139.52±5.79 mg/dl on Day 75 and 144.65±5.71 mg/dl on Day 90. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in serum cholesterol levels from Day 60 onwards, 128.51±6.61 mg/dl on Day 60, 123.57±6.12 mg/dl on Day 75 and 116.84±6.96 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in serum cholesterol levels from Day 30 onwards, 106.37±6.27 mg/dl on Day 30, 98.58±6.08 mg/dl on Day 45, 94.72±5.84 mg/dl on Day 60 and 91.32±6.69 mg/dl on Day 75 and 89.86±6.73 mg/dl on Day 90.

4.2.2b Serum HDL-cholesterol

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum total HDL-cholesterol concentration in rats are
presented in Table 6 and graphically depicted in Fig. 6. The serum HDL-cholesterol concentration in the diabetic control group (DC) was 38.58±1.65 mg/dl on Day 0, 36.91±1.54 mg/dl on Day 15, 35.24±1.82 mg/dl on Day 30, 33.93±1.90 mg/dl on Day 45, 31.52±1.33 mg/dl on Day 60, 31.46±1.54 mg/dl on Day 75 and 29.23±2.13 mg/dl on Day 90. Compared to serum HDL-cholesterol concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant change serum HDL-cholesterol concentration during 90 days of experiment. Also Metformin (10 mg/kg b.w.) administered group (DME) did not show a significant change serum HDL-cholesterol concentration during 90 days of experiment.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. showed a significant increase in the serum HDL-cholesterol on Day 90, 39.19±3.16 mg/dl. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant increase in the serum HDL-cholesterol levels on Day 90, 41.82±3.24 mg/dl. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant increase in the serum HDL-cholesterol levels from Day 75 onwards, 42.93±2.64 mg/dl on Day 75 and 44.56±3.83 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant increase in serum HDL-cholesterol levels from on Day 90, 41.31±3.19 mg/dl. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant increase in serum HDL-cholesterol levels from on Day 90 onwards, 42.27±2.86 mg/dl. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant increase in serum HDL-cholesterol levels from Day 75 onwards, 44.31±2.92 mg/dl on Day 75 and 45.42±3.13 mg/dl on Day 90.
### 4.2.2c Serum LDL-cholesterol

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum LDL-cholesterol concentration in rats are presented in Table 7 and graphically depicted in Fig. 7. The serum LDL-cholesterol concentration in the diabetic control group (DC) was 41.97±3.61 mg/dl on Day 0, 55.98±3.82 mg/dl on Day 15, 64.46±3.16 mg/dl on Day 30, 84.34±4.13 mg/dl on Day 45, 82.50±4.61 mg/dl on Day 60, 89.41±4.85 mg/dl on Day 75 and 95.12±4.91 mg/dl on Day 90. Compared to serum LDL-cholesterol concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant change serum LDL-cholesterol concentration during 90 days of experiment. Metformin (10 mg/kg b.w.) administered group (DME) showed a significant decrease serum LDL-cholesterol concentration from Day 45 of experiment, 56.09±4.59 mg/dl on Day 45, 61.29±4.75 mg/dl on Day 60, 64.14±4.86 mg/dl on Day 75 and 67.13±4.91 mg/dl on Day 90.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. showed a significant decrease in the serum LDL-cholesterol from Day 45 onwards, 55.43±4.28 mg/dl on Day 45, 63.45±4.95 mg/dl on Day 60, 68.56±4.97 mg/dl on Day 75 and 75.57±4.83 mg/dl on Day 90. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the serum LDL-cholesterol levels on Day 45, 58.00±3.79 mg/dl on Day 45 onwards, 53.05±4.67 mg/dl on Day 60, 48.18±4.67 mg/dl on Day 75 and 38.85±4.82 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the serum LDL-cholesterol levels from Day 30 onwards, 39.00±3.83 mg/dl on Day 30, 31.67±4.26 mg/dl on Day 45, 27.45±5.37 mg/dl on Day 60, 20.63±5.66 mg/dl on Day 75 and 16.86±5.85 mg/dl on Day 90.
DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant decrease in serum LDL-cholesterol levels from Day 45 onwards, 50.51±4.26 mg/dl on Day 45, 58.46±4.75 mg/dl on Day 60, 64.48±4.36 mg/dl on Day 75 and 68.56±4.85 mg/dl on Day 90. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in serum LDL-cholesterol levels from on Day 45 onwards, 61.50±4.87 mg/dl on Day 45, 55.30±4.96 mg/dl on Day 60, 52.07±4.88 mg/dl on Day 75 and 43.89±4.93 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in serum LDL-cholesterol levels from Day 30 onwards, 36.25±4.94 mg/dl on Day 30, 27.52±4.97 mg/dl on Day 45, 23.74±5.34 mg/dl on Day 60, 19.00±5.26 mg/dl on Day 75 and 16.61±5.54 mg/dl on Day 90.

**4.2.2d Serum VLDL-cholesterol**

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum VLDL-cholesterol concentration in rats are presented in Table 8 and graphically depicted in Fig. 8. The serum VLDL-cholesterol concentration in the diabetic control group (DC) was 31.60±0.94 mg/dl on Day 0, 32.52±1.24 mg/dl on Day 15, 33.57±1.19 mg/dl on Day 30, 34.58±1.27 mg/dl on Day 45, 35.65±1.18 mg/dl on Day 60, 36.49±1.21 mg/dl on Day 75 and 37.62±1.32 mg/dl on Day 90. Compared to serum VLDL-cholesterol concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant decrease in serum VLDL-cholesterol concentration during 90 days of experiment. Metformin (10 mg/kg b.w.) administered group (DME) showed a significant decrease serum VLDL-cholesterol concentration from Day 75 of experiment, 31.94±1.13 mg/dl on Day 75 and 32.24±1.09 mg/dl on Day 90.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. did not show a significant decrease in the serum VLDL-cholesterol
concentration during 90 days of experiment. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the serum VLDL-cholesterol levels from Day 75 onwards, 31.23±1.03 mg/dl on Day 75 and 30.87±1.07 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the serum VLDL-cholesterol levels from Day 60 onwards, 30.38±0.89 mg/dl on Day 60, 29.35±0.83 mg/dl on Day 75 and 28.67±0.92 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. did not show a significant decrease in serum VLDL-cholesterol concentration during 90 days of experiment. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in serum VLDL-cholesterol levels from Day 75 onwards, 31.34±0.93 mg/dl on Day 75 and 30.68±1.07 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in serum VLDL-cholesterol levels from Day 45 onwards, 29.69±0.94 mg/dl on Day 45, 28.85±0.99 mg/dl on Day 60, 28.01±1.10 mg/dl on Day 75 and 27.83±1.02 mg/dl on Day 90.

4.2.2 Serum Triglycerides

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum triglycerides concentration in rats are presented in Table 9 and graphically depicted in Fig. 9. The serum triglycerides concentration in the diabetic control group (DC) was 158.36±4.61 mg/dl on Day 0, 162.58±5.85 mg/dl on Day 15, 167.85±5.17 mg/dl on Day 30, 172.91±5.43 mg/dl on Day 45, 178.27±5.29 mg/dl on Day 60, 182.46±5.56 mg/dl on Day 75 and 188.14±5.81 mg/dl on Day 90. Compared to serum triglycerides concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant decrease in serum triglycerides
concentration during 90 days of experiment. Also Metformin (10 mg/kg b.w.) administered group (DME) did not show a significant decrease in serum triglycerides concentration during 90 days of experiment.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. did not show a significant decrease in the serum triglycerides concentration during 90 days of experiment. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the serum triglycerides levels from Day 75 onwards, 156.17±5.72 mg/dl on Day 75 and 154.37±5.95 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the serum triglycerides levels from Day 60 onwards, 151.91±6.75 mg/dl on Day 60, 146.76±8.22 mg/dl on Day 75 and 143.37±6.26 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. did not show a significant decrease in serum triglycerides concentration during 90 days of experiment. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in serum triglycerides levels from on Day 75 onwards, 156.73±5.73 mg/dl on Day 75 and 153.41±5.95 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in serum triglycerides levels from Day 45 onwards, 148.37±4.93 mg/dl on Day 45, 144.29±5.46 mg/dl on Day 60, 140.05±5.72 mg/dl on Day 75 and 139.16±5.66 mg/dl on Day 90.

4.2.2f Serum Phospholipids

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum phospholipids concentration in rats are presented in Table 10 and graphically depicted in Fig. 10. The serum phospholipids concentration in the diabetic control group (DC) was 126.34±4.61 mg/dl on Day 0,
131.13±4.83 mg/dl on Day 15, 134.83±5.16 mg/dl on Day 30, 137.29±5.46 mg/dl on Day 45, 141.28±5.13 mg/dl on Day 60, 144.91±5.72 mg/dl on Day 75 and 149.72±5.53 mg/dl on Day 90. Compared to serum phospholipids concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant decrease in serum phospholipids concentration during 90 days of experiment. Also Metformin (10 mg/kg b.w.) administered group (DME) did not show a significant decrease in serum phospholipids concentration during 90 days of experiment.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. did not show a significant decrease in the serum phospholipids concentration during 90 days of experiment. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the serum phospholipids levels from Day 75 onwards, 122.16±4.93 mg/dl on Day 75 and 120.15±5.28 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the serum phospholipids levels from Day 60 onwards, 120.42±5.38 mg/dl on Day 60, 116.19±5.61 mg/dl on Day 75 and 112.42±5.43 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant decrease in serum phospholipids concentration on Day 90 of experiment, 122.34±5.16 on Day 90. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in serum phospholipids levels from on Day 75 onwards, 121.42±5.16 mg/dl on Day 75 and 118.47±5.72 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in serum phospholipids levels from Day 60
onwards, 116.27±5.11 mg/dl on Day 60, 111.34±5.73 mg/dl on Day 75 and 107.59±5.76 mg/dl on Day 90.

4.2.2f Serum Total Lipids

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum total lipids concentration in rats are presented in Table 11 and graphically depicted in Fig. 11. The serum total lipids concentration in the diabetic control group (DC) was 396.85±15.36 mg/dl on Day 0, 419.12±15.82 mg/dl on Day 15, 435.95±16.37 mg/dl on Day 30, 463.05±16.53 mg/dl on Day 45, 468.22±17.26 mg/dl on Day 60, 484.73±17.25 mg/dl on Day 75 and 499.83±17.68 mg/dl on Day 90. Compared to serum total lipids concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant decrease in serum total lipids concentration during 90 days of experiment. Also Metformin (10 mg/kg b.w.) administered group (DME) did not show a significant decrease in serum total lipids concentration during 90 days of experiment.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w. did not show a significant decrease in the serum total lipids concentration during 90 days of experiment. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the serum total lipids levels from Day 75 onwards, 397.80±18.28 mg/dl on Day 75 and 386.06±18.64 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the serum total lipids levels from Day 45 onwards, 380.10±16.85 mg/dl on Day 45, 371.67±17.26 mg/dl on Day 60, 355.86±17.35 mg/dl on Day 75 and 345.88±17.38 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. did not show significant decrease in serum total lipids concentration during
experiment. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in serum total lipids levels from on Day 75 onwards, 401.72±18.38 mg/dl on Day 75 and 388.72 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in serum total lipids levels from Day 45 onwards, 367.68±17.26 mg/dl on Day 45, 355.28±17.89 mg/dl on Day 60, 242.71±18.64 mg/dl on Day 60 and 336.61±18.98 mg/dl on Day 90.

4.2.3 Antioxidant and Tissue protective activity

4.2.3a Serum Creatinine

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum creatinine concentration in rats are presented in Table 12 and graphically depicted in Fig. 12. The serum creatinine concentration in the diabetic control group (DC) was 0.76±0.13 mg/dl on Day 0, 0.83±0.16 mg/dl on Day 15, 0.96±0.19 mg/dl on Day 30, 1.34±0.21 mg/dl on Day 45, 1.62±0.20 mg/dl on Day 60, 1.89±0.23 mg/dl on Day 75 and 2.12±0.23 mg/dl on Day 90. Compared to serum creatinine concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) showed a significant decrease in serum creatinine concentration from Day 75 of experiment, 0.99±0.19 mg/dl on Day 75 and 1.24±0.20 mg/dl on Day 90. Metformin (10 mg/kg b.w.) administered group (DME) showed a significant decrease in serum creatinine concentration from Day 60 of experiment, 0.92±0.21 mg/dl on Day 60, 1.12±0.18 mg/dl on Day 75 and 1.06±0.23 mg/dl on Day 90.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w., showed a significant decrease in serum creatinine concentration from Day 60 of experiment, 0.87±0.19 mg/dl on Day 60, 0.85±0.21 mg/dl on Day 75 and 0.83±0.21 mg/dl on Day 90. DA2 group administered with aqueous extract at the dose of 400
mg/kg b.w. showed a significant decrease in the serum creatinine levels from Day 60 onwards, 0.71±0.150.87±0.19 mg/dl on Day 60, 0.68±0.180.87±0.19 mg/dl on Day 75 and 0.64±0.180.87±0.19 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the serum creatinine levels from Day 60 onwards, 0.65±0.19 mg/dl on Day 60, 0.61±0.21 mg/dl on Day 75 and 0.56±0.22 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant decrease in serum creatinine concentration from Day 60 of experiment, 0.91±0.16 mg/dl on Day 60, 0.90±0.19 mg/dl on Day 75 and 0.88±0.19 mg/dl on Day 90. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in serum creatinine levels from on Day 60 onwards, 0.66±0.16 mg/dl on Day 60, 0.62±0.19 mg/dl on Day 75 and 0.59±0.18 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in serum creatinine levels from Day 60 onwards, 0.69±0.18 mg/dl on Day 60, 0.62±0.19 mg/dl on Day 75 and 0.54±0.18 mg/dl on Day 90.

4.2.3b Blood Urea Nitrogen (BUN)

The effect of administration of different doses of aqueous and methanol extracts of Murraya koenigii on BUN concentration in rats are presented in Table 13 and graphically depicted in Fig. 13. The BUN concentration in the diabetic control group (DC) was 28.36±2.64 mg/dl on Day 0, 34.26±3.26 mg/dl on Day 15, 38.16±3.46 mg/dl on Day 30, 47.16±2.89 mg/dl on Day 45, 51.26±3.49 mg/dl on Day 60, 58.43±4.16 mg/dl on Day 75 and 66.49±5.58 mg/dl on Day 90. Compared to BUN concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) showed a significant decrease in BUN concentration on Day 90 of experiment, 48.61±3.49 mg/dl on Day 90. Metformin (10
mg/kg b.w.) administered group (DME) showed a significant decrease in BUN concentration from Day 60 of experiment, 38.56±3.51 mg/dl on Day 60, 41.29±3.42 mg/dl on Day 75 and 43.82±3.42 mg/dl on Day 90.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w., showed a significant decrease in BUN concentration from Day 60 of experiment, 34.68±3.14 mg/dl on Day 60, 31.26±3.28 mg/dl on Day 75 and 32.68±3.44 mg/dl on Day 90. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the BUN levels from Day 45 onwards, 31.26±2.94 mg/dl on Day 45, 28.73±2.86 mg/dl on Day 60, 28.16±3.18 mg/dl on Day 75 and 26.12±3.27 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the BUN levels from Day 45 onwards, 29.46±3.25 mg/dl on Day 45, 28.18±3.46 mg/dl on Day 60, 26.19±3.24 mg/dl on Day 75 and 24.68±3.18 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant decrease in BUN concentration from Day 45 of experiment, 32.69±2.91 mg/dl on Day 45, 34.16±2.64 mg/dl on Day 60, 33.82±3.08 mg/dl on Day 75 and 30.64±3.11 mg/dl on Day 90. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in BUN levels from on Day 45 onwards, 33.26±3.19 mg/dl on Day 45, 31.64±3.06 mg/dl on Day 60, 28.73±3.33 mg/dl on Day 75 and 26.12±3.21 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in BUN levels from Day 30 onwards, 26.35±2.65 mg/dl on Day 30, 27.64±2.51 mg/dl on Day 45, 26.43±2.85 mg/dl on Day 60, 24.36±2.69 mg/dl on Day 75 and 23.37±2.94 mg/dl on Day 90.
4.2.3c Serum Alanine Aminotransferase (ALT)

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on ALT concentration in rats are presented in Table 14 and graphically depicted in Fig. 14. The ALT concentration in the diabetic control group (DC) was 46.36±3.58 U/l on Day 0, 52.26±10.36 U/l on Day 15, 86.46±16.59 U/l on Day 30, 146.49±22.64 U/l on Day 45, 194.36±24.16 U/l on Day 60, 249.49±34.16 U/l on Day 75 and 327.26±41.36 U/l on Day 90. Compared to ALT concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) showed a significant decrease in ALT concentration on Day 90 of experiment, 218.36±28.42 U/l on Day 90. Metformin (10 mg/kg b.w.) administered group (DME) showed a significant decrease in ALT concentration on Day 90 of experiment, 173.71±31.28 U/l on Day 90.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w., showed a significant decrease in ALT concentration from Day 75 of experiment, 123.46±23.16 U/l on Day 75 and 138.97±28.43 U/l on Day 90. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the ALT levels from Day 60 onwards, 98.61±18.53 U/l on Day 60, 76.28±18.86 U/l on Day 75 and 66.79±21.54 U/l on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the ALT levels from Day 45 onwards, 55.19±16.82 U/l on Day 45, 48.47±19.43 U/l on Day 60, 39.51±18.18 U/l on Day 75 and 36.82±18.31 U/l on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant decrease in ALT concentration from Day 75 of experiment, 109.48±18.27 U/l on Day 75 and 98.26±18.53 U/l on Day 90. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in ALT levels from on Day 60 onwards, 72.14±16.43 U/l on Day
60, 66.31±17.26 U/l on Day 75 and 61.28±19.46 U/l on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in ALT levels from Day 45 onwards, 55.26±16.48 U/l on Day 45, 48.49±14.52 U/l on Day 60, 41.63±12.38 U/l on Day 75 and 38.59±15.69 U/l on Day 90.

4.2.3d Serum Aspartate Aminotransferase (AST)

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on AST concentration in rats are presented in Table 15 and graphically depicted in Fig. 15. The AST concentration in the diabetic control group (DC) was 38.53±4.62 U/l on Day 0, 54.61±9.56 U/l on Day 15, 78.26±10.58 U/l on Day 30, 128.56±11.29 U/l on Day 45, 186.52±18.64 U/l on Day 60, 243.28±19.28 U/l on Day 75 and 288.64±21.64 U/l on Day 90. Compared to AST concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) showed a significant decrease in AST concentration from Day 60 of experiment, 128.42±12.57 on Day 60, 157.67±18.54 on Day 75 and 197.27±18.57 on Day 90. Metformin (10 mg/kg b.w.) administered group (DME) showed a significant decrease in AST concentration from Day 60 of experiment, 94.67±12.46 on Day 60, 129.65±15.46 on Day 75 and 138.46±15.73 on Day 90.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w., showed a significant decrease in AST concentration from Day 45 of experiment, 66.29±18.42 on Day 45, 78.43±17.69 on Day 60, 88.29±19.45 on Day 75 and 112.37±19.56 on Day 90. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the AST levels from Day 45 onwards, 51.67±14.67 on Day 45, 48.26±14.68 on Day 60, 44.57±15.28 on Day 75 and 40.37±18.27 on Day 90. DA3 group administered with aqueous extract at the
dose of 800 mg/kg b.w. showed a significant decrease in the AST levels from Day 45 onwards, 41.39±9.28 on Day 45, 38.29±13.57 on Day 60, 36.43±16.49 on Day 75 and 32.76±18.94 on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. showed a significant decrease in AST concentration from Day 45 of experiment, 61.29±16.46 on Day 45, 59.67±14.67 on Day 60, 55.67±16.82 on Day 75 and 52.67±17.68 on Day 90. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in AST levels from Day 45 onwards, 46.59±12.68 on Day 45, 42.68±14.26 on Day 60, 38.49±13.56 on Day 75 and 32.19±12.59 on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in AST levels from Day 45 onwards, 36.16±15.26 on Day 45, 32.59±12.38 on Day 60, 30.58±13.56 on Day 75 and 28.43±16.42 on Day 90.

### 4.2.3e Serum Bilirubin

The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on serum bilirubin concentration in rats are presented in Table 16 and graphically depicted in Fig. 16. The bilirubin concentration in the diabetic control group (DC) was 0.65±0.13 mg/dl on Day 0, 0.82±0.19 mg/dl on Day 15, 1.35±0.22 mg/dl on Day 30, 1.49±0.24 mg/dl on Day 45, 1.56±0.28 mg/dl on Day 60, 1.71±0.29 mg/dl on Day 75 and 1.83±0.27 mg/dl on Day 90. Compared to bilirubin concentration of diabetic control group (DC) on respective Days, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant decrease in bilirubin concentration during 90 Days of experiment. Metformin (10 mg/kg b.w.) administered group (DME) did not show a significant decrease in bilirubin concentration during 90 Days of experiment.
DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w., did not show a significant decrease in bilirubin concentration during 90 Days of experiment. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in the bilirubin levels from Day 75 onwards, 0.54±0.26 mg/dl on Day 75 and 0.53±0.27 mg/dl on Day 90. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in the bilirubin levels from Day 75 onwards, 0.51±0.28 mg/dl on Day 75 and 0.46±0.28 mg/dl on Day 90.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w. did not show a significant decrease in bilirubin concentration during 90 Days of experiment. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in bilirubin levels from on Day 75 onwards, 0.69±0.22 mg/dl on Day 75 and 0.61±0.26 mg/dl on Day 90. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant decrease in bilirubin levels from Day 75 onwards, 0.58±0.26 mg/dl on Day 75 and 0.53±0.22 mg/dl on Day 90.

4.2.3f Tissue Superoxide Dismutase
The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on Tissue superoxide dismutase activity in rats are presented in Table 17 and graphically depicted in Fig. 17. Tissue superoxide dismutase activity in diabetic control group (DC) was 0.93±0.18 U/mg of protein in pancreas, 1.56±0.31 U/mg of protein in liver, 1.67±0.29 U/mg of protein in kidney and 1.43±0.23 U/mg of protein in heart. Compared to (DC) control group tissue superoxide dismutase activity, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant increase in tissue superoxide dismutase activity at the end of 90 Days of experiment. Similarly Metformin (10 mg/kg b.w.) administered group (DME) did not
show a significant increase in tissue superoxide dismutase activity at the end of 90 Days of experiment.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w., showed a significant increase in tissue superoxide dismutase activity in pancreas 2.11±0.23 U/mg of protein. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant increase in tissue superoxide dismutase activity in pancreas 2.49±0.27 U/mg of protein and kidney 5.27±0.74 U/mg of protein. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant increase in tissue superoxide dismutase activity in pancreas 3.11±0.26 U/mg of protein, liver 5.89±1.18 U/mg of protein, kidney 6.14±1.12 U/mg of protein and heart 5.43±1.11 U/mg of protein.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w., showed a significant increase in tissue superoxide dismutase activity in pancreas 2.31±0.17 U/mg of protein. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant increase in tissue superoxide dismutase activity in pancreas 2.86±0.37 U/mg of protein, kidney 5.48±1.38 U/mg of protein and heart 5.28±1.07 U/mg of protein. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant increase in tissue superoxide dismutase activity in pancreas 3.43±0.26 U/mg of protein, liver 6.43±1.42 U/mg of protein, kidney 6.11±0.94 U/mg of protein and heart 5.69±1.19 U/mg of protein.

4.2.3g Tissue Catalase
The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on tissue catalase activity in rats are presented in Table 18 and graphically depicted in Fig. 18. Tissue catalase activity in diabetic control group (DC)
was 8.31±1.26 CAT Unit/mg of protein in pancreas, 86.26±6.18 CAT Unit/mg of protein in liver, 71.38±5.37 CAT Unit/mg of protein in kidney and 69.26±5.26 CAT Unit/mg of protein in heart. Compared to (DC) control group tissue catalase activity, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) showed a significant increase in tissue catalase in liver 110.38±7.28 CAT Unit/mg of protein and kidney 90.26±5.26 CAT Unit/mg of protein. Similarly Metformin (10 mg/kg b.w.) administered group (DME) showed a significant increase in tissue catalase activity in liver 128.36±6.29 CAT Unit/mg of protein and kidney 96.18±4.96 CAT Unit/mg of protein at the end of 90 Days of experiment.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w., showed a significant increase in tissue catalase activity in liver 132.57±7.53 CAT Unit/mg of protein and kidney 98.67±5.29 CAT Unit/mg of protein. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant increase in tissue catalase activity in liver 156.37±7.26 CAT Unit/mg of protein, kidney 112.38±5.54 CAT Unit/mg of protein and heart 93.94±6.15 CAT Unit/mg of protein. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant increase in tissue catalase activity in pancreas 24.19±3.24 CAT Unit/mg of protein, liver 184.26±7.41 CAT Unit/mg of protein, kidney 135.26±6.39 CAT Unit/mg of protein and heart 118.82±6.18 CAT Unit/mg of protein.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w., showed a significant increase in tissue catalase activity in liver 138.29±6.29 CAT Unit/mg of protein and kidney 104.28±5.23 CAT Unit/mg of protein. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant increase in tissue catalase activity in pancreas 18.64±3.16 CAT Unit/mg of protein, liver 166.29±7.59 CAT Unit/mg of protein, kidney 124.86±6.57 CAT Unit/mg of protein.
Unit/mg of protein and heart 106.94±6.46 CAT Unit/mg of protein. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant increase in tissue catalase activity in pancreas 26.83±3.88 CAT Unit/mg of protein, liver 183.47±7.68 CAT Unit/mg of protein, kidney 141.68±7.16 and heart 124.73±6.84 CAT Unit/mg of protein.

4.2.3h Tissue Lipid peroxidation
The effect of administration of different doses of aqueous and methanol extracts of *Murraya koenigii* on Tissue lipid peroxidation level in rats are presented in Table 19 and graphically depicted in Fig. 19. Tissue lipid peroxidation level in diabetic control group (DC) was 6.29±0.96 nmol of MDA/g of tissue/min in pancreas, 8.36±1.21 nmol of MDA/g of tissue/min in liver, 19.34±2.67 nmol of MDA/g of tissue/min in kidney and 11.93±2.52 nmol of MDA/g of tissue/min in heart. Compared to (DC) control group tissue lipid peroxidation activity, glibenclamide (0.25 mg/kg b.w.) administered group (DGL) did not show a significant decrease in tissue lipid peroxidation activity at the end of 90 Days of experiment. Similarly Metformin (10 mg/kg b.w.) administered group (DME) showed a significant decrease in tissue lipid peroxidation in liver 4.29±1.10 nmol of MDA/g of tissue/min at the end of 90 Days of experiment.

DA1 group administered with aqueous extract at the dose of 200 mg/kg b.w., did not show a significant decrease in tissue lipid peroxidation activity at the end of 90 Days of experiment. DA2 group administered with aqueous extract at the dose of 400 mg/kg b.w. showed a significant decrease in tissue lipid peroxidation activity in pancreas 2.97±0.58 nmol of MDA/g of tissue/min, liver 4.25±0.83 nmol of MDA/g of tissue/min, kidney 9.53±2.06 nmol of MDA/g of tissue/min and heart 4.29±1.87 nmol of MDA/g of tissue/min. DA3 group administered with aqueous extract at the dose of 800 mg/kg b.w. showed a significant decrease in tissue lipid peroxidation activity in
pancreas $2.16 \pm 0.64$ nmol of MDA/g of tissue/min, liver $4.06 \pm 0.61$ nmol of MDA/g of tissue/min, kidney $7.68 \pm 2.19$ nmol of MDA/g of tissue/min and heart $3.68 \pm 1.94$ nmol of MDA/g of tissue/min.

DM1 group administered with methanol extract at the dose of 200 mg/kg b.w., showed a significant decrease in tissue lipid peroxidation activity in kidney $9.96 \pm 2.56$ nmol of MDA/g of tissue/min. DM2 group administered with methanol extract at the dose of 400 mg/kg b.w. showed a significant decrease in tissue lipid peroxidation activity in pancreas $3.08 \pm 0.95$ nmol of MDA/g of tissue/min, liver $4.19 \pm 0.74$ nmol of MDA/g of tissue/min, kidney $9.49 \pm 2.58$ nmol of MDA/g of tissue/min and heart $3.91 \pm 2.15$ nmol of MDA/g of tissue/min. DM3 group administered with methanol extract at the dose of 800 mg/kg b.w. showed a significant increase in tissue lipid peroxidation activity in pancreas $2.35 \pm 0.81$ nmol of MDA/g of tissue/min, liver $3.96 \pm 1.16$ nmol of MDA/g of tissue/min, kidney $8.29 \pm 1.59$ nmol of MDA/g of tissue/min and heart $3.19 \pm 1.84$ nmol of MDA/g of tissue/min.

### 4.2.4 Histopathology

Pancreas, liver, kidney and heart from Diabetic control (DC) group showed histopathological changes. Pancreas showed poor cellularity of islet of langerhans and damaged islet cells. Liver showed slight fatty degeneration, kidney revealed tubular damage, interstitial tissue proliferation and proteinacious material accumulation in glomeruli and heart showed myocardial infarction on histological study. Compared to Diabetic control group the groups treated with freeze dried aqueous leaf extracts of *Murraya koenigii* showed improved histological appearance in dose dependent manner in pancreas, liver, kidney and heart. Results are depicted through plate No.4 to Plate No.13
4.3 EXPERIMENT- III

This study was conducted to elucidate the antidiabetic, antioxidant and hypolipidemic activity of freeze dried aqueous leaf extracts of *Murraya koenigii* in Alloxan-Diabetic Wister albino rats. Freeze dried extract was tested by intraperitoneal administration at two doses viz. 25 and 50 mg/kg b.w., for a period of 4 weeks.

4.3.1 Antidiabetic activity

4.3.1a Plasma glucose

The effect of intraperitoneal administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on plasma glucose concentration in rats are presented in Table 20 and graphically depicted in Fig. 20. The plasma glucose levels in the diabetic control group (FC) was 278.65±15.67 mg/dl on Day 0, 289.56±14.36 mg/dl on Day 7, 283.64±18.46 mg/dl on Day 14, 283.16±19.72 mg/dl on Day 21 and 276.16±17.83 mg/dl on Day 28. Compared to corresponding plasma glucose levels of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in plasma glucose levels from Day 21 onwards, 188.46±20.85 mg/dl on Day 21 and 173.60±19.46 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in plasma glucose levels from Day 14 onwards, 198.27±23.54 mg/dl on Day 14, 176.46±19.43 mg/dl on Day 21 and 161.91±21.72 mg/dl on Day 28.

4.3.1b Plasma Insulin

The effect of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on plasma insulin concentration in rats are presented in Table 21 and graphically depicted in Fig. 21. The plasma insulin levels in the diabetic control group (FC) was 17.36±0.92 µU/ml on Day 0, 17.91±0.83 µU/ml on Day 7,
19.36±1.25 μU/ml on Day 14, 19.43±1.70 μU/ml on Day 21 and 19.25±1.31 μU/ml on Day 28. Compared to corresponding plasma insulin levels of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant increase in plasma insulin levels from Day 21 onwards, 25.46±1.21 μU/ml on Day 21 and 28.43±1.38 μU/ml on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant increase in plasma insulin levels from Day 14 onwards, 23.76±1.34 μU/ml on Day 14, 28.43±1.61 μU/ml on Day 21 and 30.28±1.52 μU/ml on Day 28.

4.3.2 Hypolipidemic Activity
4.3.2a Serum Total Cholesterol

The effect of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum total cholesterol concentration in rats are presented in Table 22 and graphically depicted in Fig. 22. The serum total cholesterol concentration in the diabetic control group (FC) was 118.36±5.26 mg/dl on Day 0, 132.53±5.18 mg/dl on Day 7, 141.61±5.39 mg/dl on Day 14, 156.37±5.68 mg/dl on Day 21 and 163.42±5.83 mg/dl on Day 28. Compared to corresponding serum total cholesterol concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in serum total cholesterol concentration from Day 14 onwards, 112.69±6.25 mg/dl on Day 14, 108.91±6.18 mg/dl on Day 21 and 103.72±6.37 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum total cholesterol concentration from Day 14 onwards, 109.46±6.37 mg/dl on Day 14, 98.36±6.81 mg/dl on Day 21 and 94.85±6.73 mg/dl on Day 28.
4.3.2b Serum HDL-Cholesterol

The effect of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum HDL-cholesterol concentration in rats are presented in Table 23 and graphically depicted in Fig. 23. The serum HDL-cholesterol concentration in the diabetic control group (FC) was 34.26±2.35 mg/dl on Day 0, 32.61±2.16 mg/dl on Day 7, 31.67±2.58 mg/dl on Day 14, 31.95±2.67 mg/dl on Day 21 and 30.25±2.64 mg/dl on Day 28. Compared to corresponding serum HDL-cholesterol concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant increase in serum HDL-cholesterol concentration on Day 28 40.46±2.68 mg/dl. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant increase in serum HDL-cholesterol concentration from Day 21 onwards, 41.86±2.91 mg/dl on Day 21 and 43.29±3.27 mg/dl on Day 28.

4.3.2c Serum LDL-Cholesterol

The effect of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum LDL-cholesterol concentration in rats are presented in Table 24 and graphically depicted in Fig. 24. The serum LDL-cholesterol concentration in the diabetic control group (FC) was 53.566±3.26 mg/dl on Day 0, 68.182±3.58 mg/dl on Day 7, 76.648±3.92 mg/dl on Day 14, 90.084±4.28 mg/dl on Day 21 and 97.626±5.17 mg/dl on Day 28. Compared to corresponding serum LDL-cholesterol concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant increase in serum LDL-cholesterol concentration from Day 7 onwards 52.806±3.72 mg/dl on Day 7, 44.756±3.91 mg/dl on Day 14, 40.908±4.65 mg/dl on Day 21 and 34.874±5.26 mg/dl on Day 28. F2 group administered with
aqueous extract at the dose of 50 mg/kg b.w. showed a significant increase in serum LDL-cholesterol concentration from Day 7 onwards, 49.984±4.16 mg/dl on Day 7, 40.762±4.28 mg/dl on Day 14, 25.092±5.19 mg/dl on Day 21 and 24.214±5.43 mg/dl on Day 28.

4.3.2d Serum VLDL-Cholesterol
The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum VLDL-cholesterol concentration in rats are presented in Table 25 and graphically depicted in Fig. 25. The serum VLDL-cholesterol concentration in the diabetic control group (FC) was 30.53±1.32 mg/dl on Day 0, 31.73±1.26 mg/dl on Day 7, 33.29±1.19 mg/dl on Day 14, 34.33±1.38 mg/dl on Day 21 and 35.54±1.41 mg/dl on Day 28. Compared to corresponding serum VLDL-cholesterol concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in serum VLDL-cholesterol concentration from Day 21 onwards 29.31±1.47 mg/dl on Day 21 and 28.38±1.41 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum VLDL-cholesterol concentration from Day 21 onwards, 27.89±1.38 mg/dl on Day 21 and 27.34±1.40 mg/dl on Day 28.

4.3.2e Serum Triglyceride
The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum triglyceride concentration in rats are presented in Table 26 and graphically depicted in Fig. 26. The serum triglyceride concentration in the diabetic control group (FC) was 152.67±5.16 mg/dl on Day 0, 158.69±5.29 mg/dl on Day 7, 166.46±5.43 mg/dl on Day 14, 171.68±5.73 mg/dl on Day 21 and 177.72±5.81 mg/dl on Day 28. Compared to corresponding serum triglyceride
concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in serum triglyceride concentration from Day 21 onwards 146.56±5.82 mg/dl on Day 21 and 141.93±5.75 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum triglyceride concentration from Day 21 onwards, 139.49±5.76 mg/dl on Day 21 and 136.73±5.89 mg/dl on Day 28.

4.3.2f Serum Phospholipids
The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum phospholipids concentration in rats are presented in Table 27 and graphically depicted in Fig. 27. The serum phospholipids concentration in the diabetic control group (FC) was 118.64±4.68 mg/dl on Day 0, 121.58±4.92 mg/dl on Day 7, 125.46±4.85 mg/dl on Day 14, 128.46±5.13 mg/dl on Day 21 and 131.82±5.42 mg/dl on Day 28. Compared to corresponding serum phospholipids concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in serum phospholipids concentration from on Day 28 108.46±4.75 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum phospholipids concentration from Day 21 onwards, 107.16±4.82 mg/dl on Day 21 and 101.57±4.69 mg/dl on Day 28.

4.3.2g Serum Total Lipids
The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum total lipids concentration in rats are presented in Table 28
and graphically depicted in Fig. 28. The serum total lipids concentration in the diabetic control group (FC) was 389.67±15.10 mg/dl on Day 0, 412.80±15.39 mg/dl on Day 7, 433.53±15.67 mg/dl on Day 14, 456.51±16.54 mg/dl on Day 21 and 472.96±17.06 mg/dl on Day 28. Compared to corresponding serum total lipids concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in serum total lipids concentration from on from Day 14 onwards 378.53±16.54 mg/dl on Day 14, 367.83±16.69 mg/dl on Day 21 and 354.11±16.87 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum total lipids concentration from Day 14 onwards, 367.34±17.02 mg/dl on Day 14, 345.01±17.39 mg/dl on Day 21 and 333.15±17.31 mg/dl on Day 28.

4.3.3 Antioxidant and tissue protective effect

4.3.3a Serum Creatinine

The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum creatinine concentration in rats are presented in Table 29 and graphically depicted in Fig. 29. The serum creatinine concentration in the diabetic control group (FC) was 0.68±0.12 mg/dl on Day 0, 0.77±0.15 mg/dl on Day 7, 0.89±0.13 mg/dl on Day 14, 1.12±0.16 mg/dl on Day 21 and 1.36±0.18 mg/dl on Day 28. Compared to corresponding serum creatinine concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in serum creatinine concentration on Day 28, 0.64±0.18 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum creatinine concentration from Day 21 onwards, 0.53±0.18 mg/dl on Day 21 and 0.51±0.19 mg/dl on Day 28.
4.3.3b Blood Urea Nitrogen (BUN)

The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on BUN concentration in rats are presented in Table 30 and graphically depicted in Fig. 30. The BUN concentration in the diabetic control group (FC) was 26.39±2.34 mg/dl on Day 0, 29.36±2.46 mg/dl on Day 7, 32.18±2.57 mg/dl on Day 14, 38.49±2.86 mg/dl on Day 21 and 43.69±2.81 mg/dl on Day 28. Compared to corresponding BUN concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in BUN concentration from Day 21, 25.19±2.83 mg/dl on Day 21 and 24.36±2.96 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in BUN concentration from Day 21 onwards, 23.49±2.94 mg/dl on Day 21 and 21.57±3.11 mg/dl on Day 28.

4.3.3c Serum Bilirubin

The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum bilirubin concentration in rats are presented in Table 31 and graphically depicted in Fig. 31. The serum bilirubin concentration in the diabetic control group (FC) was 0.62±0.13 mg/dl on Day 0, 0.78±0.12 mg/dl on Day 7, 0.95±0.16 mg/dl on Day 14, 1.12±0.18 mg/dl on Day 21 and 1.23±0.19 mg/dl on Day 28. Compared to corresponding serum bilirubin concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in serum bilirubin concentration on Day 28, 0.55±0.19 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum
bilirubin concentration from Day 21 onwards, 0.54±0.18 mg/dl on Day 21 and 0.51±0.19 mg/dl on Day 28.

4.3.3d Serum alanine aminotransferase (ALT)
The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum ALT concentration in rats are presented in Table 32 and graphically depicted in Fig. 32. The serum ALT concentration in the diabetic control group (FC) was 43.98±3.86 mg/dl on Day 0, 51.36±6.16 mg/dl on Day 7, 79.19±12.36 mg/dl on Day 14, 128.69±16.49 mg/dl on Day 21 and 169.76±18.43 mg/dl on Day 28. Compared to corresponding serum ALT concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in serum ALT concentration from Day 21, 48.36±8.16 mg/dl on Day 21 and 48.12±8.37 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum ALT concentration from Day 14 onwards, 41.69±8.46 mg/dl on Day 14, 39.42±10.31 mg/dl on Day 21 and 37.37±9.14 mg/dl on Day 28.

4.3.3e Serum aspartate aminotransferase (AST)
The effects of administration of different doses of freeze dried aqueous extract of *Murraya koenigii* on serum AST concentration in rats are presented in Table 33 and graphically depicted in Fig. 33. The serum AST concentration in the diabetic control group (FC) was 36.43±5.16 mg/dl on Day 0, 46.82±5.39 mg/dl on Day 7, 61.26±8.36 mg/dl on Day 14, 95.15±9.76 mg/dl on Day 21 and 127.61±10.36 mg/dl on Day 28. Compared to corresponding serum AST concentration of diabetic control group (FC) on respective Days, F1 group administered with freeze dried aqueous extract at the
dose of 25 mg/kg b.w. showed a significant decrease in serum AST concentration from Day 21, 40.85±9.43 mg/dl on Day 21 and 38.75±9.76 mg/dl on Day 28. F2 group administered with aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in serum AST concentration from Day 21 onwards, 32.13±9.43 mg/dl on Day 21 and 31.84±10.74 mg/dl on Day 28.

4.3.3f Tissue Superoxide Dismutase
The effects of administration of different doses of freeze dried aqueous extract of Murraya koenigii on tissue superoxide dismutase activity in rats are presented in Table 34 and graphically depicted in Fig. 34. Tissue superoxide dismutase activity in diabetic control group (FC) was 0.88±0.16 U/mg of protein in pancreas, 1.86±0.28 U/mg of protein in liver, 1.87±0.31 U/mg of protein in kidney and 1.52±0.33 U/mg of protein in heart. Compared to tissue superoxide dismutase activity of diabetic control group (FC), F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant increase in tissue superoxide dismutase activity at the end of 28 Days of experiment in pancreas 2.12±0.19 U/mg of protein, liver 4.67±0.82 U/mg of protein and kidney 4.98±0.86 U/mg of protein. F2 group administered with freeze dried aqueous extract at the dose of 50 mg/kg b.w. showed a significant increase in tissue superoxide dismutase activity at the end of 28 Days of experiment in pancreas 2.89±0.21 U/mg of protein, liver 4.98±0.98 U/mg of protein, kidney 5.84±1.06 U/mg of protein and kidney 5.19±1.34 U/mg of protein.

4.3.3g Tissue Catalase
The effects of administration of different doses of freeze dried aqueous extract of Murraya koenigii on tissue catalase activity in rats are presented in Table 35 and graphically depicted in Fig. 35. Tissue catalase activity in diabetic control group (FC)
was 7.98±1.16 CAT Unit/mg of protein in pancreas, 78.36±7.26 CAT Unit/mg of protein in liver, 65.49±5.46 CAT Unit/mg of protein in kidney and 61.43±6.35 CAT Unit/mg of protein in heart. Compared to (FC) control group tissue catalase activity, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant increase in tissue catalase at the end of 28 Days of experiment in liver 146.85±8.26 CAT Unit/mg of protein and kidney 109.46±4.96 CAT Unit/mg of protein. F2 group administered with freeze dried aqueous extract at the dose of 50 mg/kg b.w. showed a significant increase in tissue catalase activity at the end of 28 Days of experiment in pancreas 19.37±3.65 CAT Unit/mg of protein, liver 172.94±8.72 CAT Unit/mg of protein, kidney 128.15±5.92 and heart 98.28±5.81 CAT Unit/mg of protein.

4.3.3h Tissue Lipid peroxidation

The effects of administration of different doses of freeze dried aqueous extract of Murraya koenigii on Tissue lipid peroxidation level in rats are presented in Table 36 and graphically depicted in Fig. 36. Tissue lipid peroxidation level in diabetic control group (FC) was 5.92±0.86 nmol of MDA/g of tissue/min in pancreas, 7.69±1.19 nmol of MDA/g of tissue/min in liver, 18.64±2.61 nmol of MDA/g of tissue/min in kidney and 12.58±2.69 nmol of MDA/g of tissue/min in heart. Compared to (FC) control group tissue lipid peroxidation activity, F1 group administered with freeze dried aqueous extract at the dose of 25 mg/kg b.w. showed a significant decrease in tissue lipid peroxidation activity at the end of 28 Days of experiment in liver 3.94±0.68 nmol of MDA/g of tissue/min and kidney 11.35±2.48 nmol of MDA/g of tissue/min. F2 group administered with freeze dried aqueous extract at the dose of 50 mg/kg b.w. showed a significant decrease in tissue lipid peroxidation in pancreas 2.76±0.92 nmol of MDA/g of tissue/min, liver 3.52±1.29 nmol of MDA/g of tissue/min, kidney
9.16±1.26 nmol of MDA/g of tissue/min and heart 4.67±1.68 nmol of MDA/g of tissue/min.

**4.3.4 Histopathology**

Pancreas and liver from Diabetic control (DC) group showed histopathological changes. Pancreas showed poor cellularity of islet of langerhans and damaged islet cells. Liver showed slight fatty degeneration. Kidney and heart showed normal histological features on histological study.

Compared to Diabetic control group the groups treated with freeze dried aqueous leaf extract of *Murraya koenigii* showed improved histological appearance in dose dependent manner in pancreas and liver. Results are depicted through plate No.14 to Plate No.18

**4.4 EXPERIMENT-IV**

**4.4.1 Oral Glucose Tolerance Test**

The effect of aqueous, methanol and freeze dried aqueous leaf extract *Murraya koenigii* on Glucose tolerance test are presented in Table 3 and graphically depicted in Fig. 37. Plasma glucose levels in diabetic control group (GC) was 257.36±18.49 mg/dl at –30 min, 256.34±19.76 mg/dl at 0 min, 372.83±21.81 mg/dl at 30 min, 350.49±19.46 mg/dl at 60 min, 305.58±18.35 mg/dl at 120 min and 282.39±16.59 mg/dl at 180 min.

Compared to control group (FC) plasma glucose levels in G 1 group administered orally with aqueous extract at the dose of 800 mg/kg b.w. significantly attenuated the plasma glucose levels at 30 min 281.19±19.58 mg/dl and at 60 min 272.69±23.58 mg/dl. G2 group administered orally with methanol extract at the dose of 800 mg/kg b.w. significantly attenuated the plasma glucose levels at 30 min 273.36±22.58 mg/dl and 263.58±19.51 mg/dl at 60 min. G3 group administered intraperitoneally with
freeze dried aqueous extract at the dose of 800 mg/kg b.w. significantly attenuated the plasma glucose levels at 30 min 271.49±21.67 mg/dl and 267.16±18.69 mg/dl at 60 min.

4.5 EXPERIMENT-V
The protein profile studies indicated the over expression of proteins in pancreas of animals treated with aqueous and methanol leaf extracts of *Murraya koenigii* at 800 mg/kg body weight. There was over expression of proteins with molecular weights - between 10 to 20 KDa. The results are presented in Plate No.19

4.6 EXPERIMENT-VI
The repeated dose 28 days toxicity study conducted using aqueous and methanol extract did not reveal any significant changes in hematological or biochemical or histological parameters at the tested doses 200 or 400 or 800 mg/kg b.w, as compared to saline control group. The results are presented in Table No. 38 through 45 and Figure No.38 through 45.

4.7 PHYTOCHEMISTRY

4.7.1 Physical characteristics

The physical characteristics like colour, nature and yield on wt/wt basis of different solvent extracts of *Murraya koenigii* were examined. Petroleum ether extract was black colour, Sticky with 8.44% yield. Chloroform extract was greenish black colour, Sticky with 7.29% yield. Methanol extract was greenish black colour, sticky with 19.58% yield. Aqueous extract was brown colour, dry powder with 10.37% yiled. Freeze dried aqueous extract was brown colour, Hygroscopic powder with 3.28% yield.
4.7.2 Solubility Analysis

Solubility of petroleum ether, chloroform, methanol and aqueous extracts of *Murraya koenigii* leaves tested at 100mg/ml by turbidity method. Petroleum ether extract was soluble in 10% propylene glycol, 10% DMSO and 10%n-methyl formamide. Chloroform extract was soluble in 10% propylene glycol, 10% DMSO and 10% tween-80. Methanol extract was soluble in 10% propylene glycol and 10% DMSO. Aqueous extract was soluble in 10% propylene glycol and 10% DMSO. Aqueous extract was soluble in 10% propylene glycol, 10% DMSO and 0.95 saline. Freeze dried aqueous extract was soluble in 10% propylene glycol, 10% DMSO, 10%n-methyl formamide and 0.9% saline.

4.7.3 Phytochemical Analysis

All four extracts, petroleum ether, chloroform, methanol and aqueous extracts of *Murraya koenigii* leaves tested

The petroleum ether extract of *Murraya koenigii* leaves showed the presence of steroids, triterpenes, alkaloids, flavonoid, tannins, diterpenes and saponins. The chloroform extract showed the presence of steroids, alkaloids, flavonoids, tannins and glycosides. The methanol extract showed the presence of steroid, alkaloids, flavonoids, tannins, lactones, diterpenes and saponins. The aqueous extract showed the presence of alkaloids, flavonoids, lactones, tannins and Saponins and the freeze dried aqueous extract showed the presence of steroids, triterpines, alkaloids, flavonoids, lactones, tannins diterpines and Saponins. The detail of the various extracts is depicted in the table nos. 46, 47, and 48.