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# Effects Of Fractionated Bittermelon (*Momordica Charantia Linn.*) Seed Extract On Normolipidemic And Hepatoprotective Status In Type – I Diabetic Rats.

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***Abstract***
*The objective of the present study was to examine the long term effects of fractionated bittermelon (Momordica charantia Linn.) seed extract on normolipidemic and hepatoprotective status in Type – I diabetic rats. Bittermelon (Momordica charantia Linn.) commonly known as 'Karella' or "Balsam Pear" (family : Cucurbitaceae) is one of the most used plants for the treatment of diabetes mellitus [DM] and some of its late complex abnormalities including neuropathy, nephropathy retinopathy, hepatic damage, fatty liver and dyslipidemia leading to a accelerated atherosclerosis (cardio-vascular disease). Bittermelon whole fruit, fruit, fruit pulp, seeds and leaves has been used in traditional medicine for the treatment of diabetes mellitus. To evaluate the normolipidemic and hepatoprotective status of bittermelon, levels of blood sugar, serum insulin and important biochemical parameters of lipid profile and liver function were monitored in experimental animals. Fraction designated as $MCK_3$ of bittermelon seed extract were administered to experimental diabetic rats intraperitoneally at a dose of 15 mg/kg. b.wt. for 20 days while the diabetic control group received equivalent volume of saline under ideal condition (n= 6 in each case). Biochemical parameters related to lipid profile and liver function were estimated in $MCK_3$ treated Type – I diabetic rats. $MCK_3$ treatment resulted in significant reduction levels of Total cholesterol, Triglyceride, Low Density Lipoproteins (LDL – cholesterol) , Very Low Density Lipoproteins (VLDL) and Atherogenic index apart from significant elevation in the High Density Lipoproteins (HDL – cholesterol) . In addition, $MCK_3$ treatment resulted in significant reduction of hepatic markers enzymes namely . Aspartate amino transfease (AST), Alanine amino transferase (ALT), Gamma-glutamyl transferase (GGT), Alkaline phospotase (ALP). Also MCK3 treatment resulted in significant reduction of Total bilirubin as well as total proteins and Albumins at 3 hours after treatment. Fraction MCK3 appear to reduce such changes significantly suggesting hepatoprotective activity against cellular leakage and loss of functional integraty of cell membrane and proved as a cytoprotective agent preserving the residual β cell mass without further loss. Loss in hypoglycemic activity of fraction $MCK_3$ upon proteinase-K treatment indicates the proteinaceous nature of the active hypoglycemic principle(s). The active hypoglycemic principle(s) present in fraction $MCK_3$ of bittermelon (Momordica charantia Linn.) seed extract at much lower concentration (15mg/kg. b.wt.) helped to attain normolipidemic and hepatoprotective status and is able to alleviate cardiac and liver damage caused by alloxan – induced Type-I diabetes.*

***Keywords:-*** *Bittermelon (Momordica charantia Linn.), Diabetes, Insulin, normolipidemic, hepatoprotective, Type – I diabetic rats.*

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**ABBREVIATIONS**

| | | |
|---|---|---|
| $MCK_3$ | - | Momordica charantia, Karella, Fraction $K_3$ |
| DM | - | Diabetes Mellitus |
| $LFT_S$ | - | Liver Function Test(s) |
| BM | - | Bittermelon, |
| FFA | - | Free Fatty Acid |
| b.wt. | - | Body Weight |

## I. Introduction

Far from being a mere pointer of affluence and physical inactivity until recent past, diabetes, of late has been growing steadily on prevalence scale among all sections of society as the world's largest endocrine disorder, manifesting a wide array of metabolic disorders of carbohydrate, fat and protein [1] and resulting in

postprandial and fasting hyperglycemia, dyslipidemia and hyperinsulinemia [2]. Diabetes is a major global health concern and is one of the major killers in recent times [3]. Another survey conducted by Lily Diabetes [4] cautions that an every third diabetic belonging to India, conferring it the dubious diabetic capital. While type – I diabetes can be easily managed with regulated insulin administration, its repeated administration prior to every meal is not desirable, Insulin treatment, if not managed properly, occasionally can result in severe hypoglycemia, a life-threatening situation. Continued administration of therapeutics such as sulfonylureas, biguanides, thiazolidinedious and alpha glucosidase inhibitors used for the treatment of type II diabetes is also known to cause undesirable effects [5]. For this reason, there is an increased interest among diabetics for complemtary and alternatice medicine involving the use of traditional medicinal herbs and their and other dietary supplements [6]. Because of low side effects and low cost they play an important role as an alternative drug [7-11]. A recent study has estimated that upto 30% of patients with diabetes mellitus use complementary and alternative medicine [12,13]. The alternative medicine system is now gaining momentum with the knowledge of active principle(s) identified from plant species [14-18]. Herbs for diabetes treatment are not new. Since time immemorial plants and their plant extracts were used to combat diabetes. Many traditional medicines in use are delivered from medicinal plants.

Momordica charantia (Bittermelon) belonging to family Cucurbitaceae is a popular medicinal plant used for the treatment of diabetes – related conditions or late complications of diabetes amongst the indigenous population of Asia, South America, India, The Caribbean and East Africa where it is used as food as well as medicine [19]. Although the seeds, leaves stem, whole fruit and fruit pulp containing bioactive compound suchaslecting, vitamins, minerals, antioxidants, dietary fibers. The main constituents of bittermelon include triterpinoids, lipid and phenolic compounds. The seeds are the most prevalent part of the plant used medicinally as it contains steroidal saponins known as charantin, momordicine, insulin like peptide (polypeptide-P), vicin and other active hypoglycemic principle(s) [20-22].

## II. Materials And Methods

*2.1 Plant Material and Animals. Momordica charantia* seeds were procured from Indian Agriculture Research Institute (IARI), Pusa, New Delhi in August 2010 in large quantity to maintain the consistency of the stock for extract preparation. All the chemicals were of analytical grade and were procured from Sigma-Aldrich Chemical Co., USA, or Boehringer- Mannhiem, Germany, unless otherwise stated. Protamine-Zinc insulin was procured from Boots Pharmaceuticals Ltd., India. Random bred male Wistar rats of 175 – 200 g. b. wt. (12–14 weeks) were housed in the Small Animal Facility of the Department of Biochemistry, Patna University, Patna. The animals were provided with rat feed (Hindustan Lever Ltd, India) and water ad libitum regarding the use of animals institutional guidelines were followed while handling animals.

*2.2 Seed Extract Preparation and Fractionation.* All extraction and purifications were performed at 4°C. Decorticated seeds were extracted in 10 volume (w/v) of 75% ice-cold acid ethanol containing 0.2 N HCl and 1 mM PMSF and incubated overnight (O/N) at −20°C to give rise to crude extract (MCKC). This was then centrifuged at 20,000 ×g for 1 h to give rise to the pellet fraction ($MCK_0$) and the supernatant fraction ($MCK_1$). After removal of ethanol by speed-vac concentration, concentrated fraction $MCK_1$ was fractionated by differential salt precipitation using 0.1–1 M ammonium carbonate gradient (pH 7.0) followed by centrifugation at 20,000 ×g for 1 h. The insoluble and soluble fractions were designated as $MCK_2$ and $MCK_3$, respectively. Bioactivity of the fractions was measured at each step of purification.

*2.3 Induction of Diabetes in Rats.* The male adult Wistar rats (175 – 200 gm) were made diabetic by using alloxan. Briefly, alloxan was administered i.p. after starving the animals for 36 hrs at a dose of 150 mg/kg body weight (b.wt.). Animals were stabilized by lente insulin administration, (2 units per day) for 3 days. Only those animals having blood glucose level more than 300 mg per 100 mL blood were selected for further analysis.

*2.4 Evaluation of Biological Activity of Momordica charantia Seed Fractions.* The diabetic animals were grouped into experimental groups each containing minimum 5 – 6 rats. The doses of different fractions are expressed in terms of their protein content. Different groups were treated with different *Momordica charantia* seed fractions (15 mg/kg b.wt.). Diabetic animals treated with saline were included in the study as diabetic control. A group of diabetic animals treated with protamine zinc insulin (5 IU/kg b.wt., s.c.) served as standard reference control. A group of normal saline treated non-diabetic animals was also included in the study. Glucose level was measured in blood drawn from the tail vein during the study period using Bergmeyer enzymatic method [23].

*2.5 Dose and Time Kinetics of Hypoglycemic Activity of the Active Fraction.* In order to determine the time by which the active fraction is able to bring about hypoglycemic effect, a short-term (0–4.5 h) study was conducted by measuring the blood glucose levels within the indicated periods after administration. Short-term time kinetics of the active fraction in diabetic rats was determined with a dose of 15 mg/kg b.wt. administered intraperitoneally (i.p.) or insulin (5 IU/kg b.wt). The blood glucose levels were measured at different time

intervals. Optimum dose of the active fraction was determined by administering the animals with different concentrations (5–25 mg/kg b.wt.) of the active fraction. Blood glucose levels were measured at 3 h after administration.

*2.6 Effect of the Hypoglycemic activity of active fraction of Bittermelon Seed extract on biochemical Parameters in Diabetic Rats.* The rats were divided into different groups (six rats in each group): Group I— saline -treated normal non-diabetic controls, Group II — saline treated diabetic rats, Group III— diabetic rats treated with 15 mg/kg b.wt. of the active fraction, and Group IV—the diabetic rats treated with protamine zinc insulin (5 IU/kg b.wt.). The first two groups of rats were given saline daily. The active fraction and insulin were administered at the selected dosage to Groups III and IV, respectively, every day for 20 days. The rats were bled prior to sacrifice on the last day of the treatment by cervical dislocation. Blood was collected for biochemical analysis of glucose, insulin and key parameters of lipid profile and liver function test(s) in serum, which were measured in automated CPC Turbochem 100 chemistry analyzer, USA.

*2.7 Statistical Analysis.* All the results were analyzed statistically using one-way ANOVA or Student's paired t-test for paired data of different levels of significance. All the results were expressed as mean ± S.E. P values less than 0.05 were considered significant.

## III. Results And Discussion

*3.1* Type – I diabetes was induced in male wistar rats using alloxan monohydrate subcutaneously. The diabetic animals were maintained for a period of 20 days in order to assess the long term effect of fraction MCK3 of bittermelon (*Momordica charantia)* on normolipidemic and hepatoprotective status in type – I diabetic rats. Fraction MCK3 at much lower dose of 15mg/kg b.wt. was very effective in reducing blood glucose level in type – I diabetic rats. The activity of fraction MCK3 started within 3 hours of intraperitoneal injection. Repeated administration of fraction MCK3 did not result in the deterioration of hypoglycemic response in whole of the study period which was comparable to that of Protamin-Zinc insulin (5U/kg b.wt.). In other words fraction MCK3 not only reduced the levels of glucose and inhibited them from rising further but also maintain them greatly, a desirable criteria for any potential anti-diabetic agent. The MCK3 and insulin treated animals had a 100% survival during the study period of 20 days with a normal behavior. The active hypoglycemic principle(s) present in fraction MCK3 of bittermelon seed extract had favorable effect not only on blood level bur also on key parameters of lipid profile and liver function test(s).

**TABLE 1:** Effect of different fractions of *M. charantia* seed extract on blood glucose levels (mg/dL) in Type – I diabetic rats.

| Period (days) of treatment | 0 | 1 | 3 |
|---|---|---|---|
| Saline Treated Normal Control Rats | 90 ± 10 | 91 ± 8 | 88 ± 11 |
| Saline Treated Diabetic Control Rats | 457 ± 72 | 578 ± 112 | 655 ± 98 |
| MCK1 Treated Diabetic Rats | 412 ± 48 | 362 ± 27* | 331 ± 14* |
| MCK2 Treated Diabetic Rats | 366 ± 72 | 493 ± 92 | NM |
| MCK3 Treated Diabetic Rats | 368 ± 57 | 299 ± 29* | 270 ± 30*** |
| Insulin Treated Diabetic Rats | 351 ± 68 | 324 ± 25* | 295 ± 18** |

The diabetic rats were treated with different fractions (MCK1, MCK2, and MCK3) at a dose of 15 mg/kg b.wt. and protamine zinc insulin (5 IU/kg b.wt), once daily for 3 days. Normal control and diabetic control animals were treated with corresponding volume of saline (0.5 ml). The data represent mean ± S.E. Each group consisted of at least 5-6 animals. $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$ compared with the respective group on day 0. NM indicates "not measured."

*3.2 Dose and Time Kinetics of Hypoglycemic Effect of active fraction MCK3.* Since fraction MCK3 was found to possess enriched hypoglycemic activity, it was desirable to study how quickly fraction MCK3 could exert its hypoglycemic effect after administration. Therefore, blood glucose levels of the MCK3 treated animals were measured at different time after administration for a short period of 4.5 h. The fraction MCK3 was able to bring down the blood glucose levels significantly by three hours and maintain the same even at 4.5 h after administration. Blood glucose levels were significantly reduced (~40%) in the diabetic animals treated with insulin within 1.5 h, which continued to remain lower during the experimental period. In order to assess the optimum concentration of MCK3 that was able to bring about significant reduction in blood glucose levels of diabetic animals, the animals were administered with different concentrations of the fraction MCK3 (5–25 mg/kg b.wt.) and the blood glucose levels were determined at 3 hr after administration (the time point determined earlier for visualizing the effect). It was observed that MCK3 showed an increased reduction in blood glucose levels till 15 mg/kg b.wt. No further reduction in the blood glucose levels was observed when the animals were treated with a higher concentration (20 mg/kg b.wt.) of fraction MCK3 Loss of activity upon heat

treatment and proteinase-K treatment of fraction MCK3 confirmed the principle(s) to be of proteinaceous in nature (Table 2).

*3.3 Effect of Long-Term Fraction MCK3 Treatment of Diabetic Animals.* In order to assess the long-term effect of fraction MCK3, the diabetic animals were maintained on fraction MCK3for a period of 20 days in order to assess if the continued administration of the active fraction MCK3 had some toxic or undesirable effect. As expected, the blood glucose levels of the animals treated daily with MCK3 were lower when compared to initial levels prior to the treatment (Table 3). A single daily injection of protamine zinc insulin ( 5 U/ kg b.wt.) was able to maintain blood glucose levels in diabetic animals and resulted in slightly reduced blood glucose levels after one week of treatment. Unlike, the MCK3 and insulin-treated group, the saline-treated diabetic animals showed continued increase in blood glucose levels. Mortality of the diabetic animals was also significantly reduced by administration of different fractions of *Momordica charantia* seed extracts. The fraction MCK3 treated animals had a 100% survival during the study period of three weeks with a normal behaviour, whereas the untreated control diabetic animals were lethargic, week and showed only about 40% survival by the end of three-week period.

*3.4 Effect of Fraction MCK3 on Lipid Profile.* Administration of fraction MCK3 (15mg/kg b.wt., i.p.) in Type – I diabetic rats for 20 days resulted in significant reduction in serum total cholesterol (43.3%) triglyceride (26.8%) and LDL-cholesterol (56.9%) levels as compared to insulin (5U/kg b.wt., i.p.). Treatment of diabetic rats with fraction MCK3 showed significant elevation in the HDL-cholesterol level (7.0%) in treated Type – I diabetic rats. In addition, fraction MCK3 showed significant ($P<0.05$) reduction in atherogenic index as comparable to insulin. Administration of MCK3 (15mg/kg b.wt., i.p.) in Type – I diabetic rats for 20 days significantly decreased the concentration of AST, ALT and GGT by 7.0 %, 14.0% and 31.0% respectively. Serum ALP and BIL-T concentration were also significantly decreased by 17.4% and 30.0% respectively following the fraction MCK3 administration In addition administration of fraction MCK3 (15 mg/kg b.wt., i.p.) had significantly increased the serum total protein by 24.0% and albumin by 23.6% in Type – I diabetic rats . Both MCK3 and insulin has abled to prevent mortality in diabetic rats. The repeated administration of fraction MCK3 did not result in the deterioration of hypoglycaemic response in diabetic rats (in terms of blood glucose level), even one week after discontinuation of treatment a desirable criteria for any potential anti-diabetic hypoglycaemic principle(s). No visible side effect or toxicity was observerd in MCK3 treated Type – I diabetic group of animals during entire experimental period of 20 days. Diabetes is usually associated with derangement in fat metabolism, alterations in the plasma lipids and lipoprotein profile. This certainly contributes to the development of cardio-vascular disease. Treatment with fraction MCK3 at a much lower dose of 15 mg/kg b.wt. significantly and greatly alleviate dyslipidemia indicating its potent antihyperlipidemic and anti-atherogenic activity. The fraction MCK3 improved lipid metabolism apart from the direct interaction with glucose homeostasis. The decreased level of serum cholesterol, LDL-cholesterol and increased level of HDL-cholesterol are considered to be favourable, since their is highly positive correlation between serum cholesterol level and incidence of atherosclerosis but negative for HDL-cholesterol [24]. Early studies suggests the antiatherogenic activity of bittermelon [25]. Similar observations also suggests that bittermelon for the treatment/prevention of dietary fatty liver. The triglyceride lowering property of bittermelon could in directly contribute to the overall antihyperglycemic activity through a mechanism of so called glucose-fatty acid cycle [26]. According to it increased supply of plasma triglyceride perse percent could constitute a source of increased FFA availability and oxidation that than can impair insulin action, glucose metabolism and utilization leading to development of hyperglycemia. Therefore, the reduction of triglyceride following MCK3 treatment also facilitate glucose oxidation and utilization and subsequently the reduction of hyperglycaemic. This is further substantiated by the fact that fraction MCK3 is effective enough in either, in stimulating insulin release from residual β-cells or due to its insulinomimetic activity or combination of the two, might in tern produce an overall improvement in lipid profile [27]. It is of interest to note that the treatment of Type – I diabetic rats with fraction MCK3 at a much lower dose of 15 mg/kg b.wt. resulted in reduction in the serum levels of marker enzymes of liver function namely AST, ALT and GGT. An increase in the serum levels of hepatic function marker these enzymes, in turn, reflects the onset of hepacellular necrosisor increased membrane permeability caused by chronic diabetes [28-29].

However early study also reported significant increase in GGT and ALP levels upon oral administration of fruit juice without causing any consistent histopathological changes in liver. Such an increase, according to study, may be due to chronic ether anaesthesia they had used [30]. Further, the two transaminases AST and ALT, belong to gluconeogenesis pathway and their increased concentrations in serum in diabetic condition further increase blood glucose levels by concerting noncarbohydrate sources in the blood to glucose. Thus, a reduction in the levels of these marker enzymes along with MCK3 treatment documenting its role as cytoprotective agent. Hematological alternations in Type – I diabetic rats could be the reason for the increased levels of total bilirubin in serum. The elevation of serum GGT concentration is regarded as one of the most sensitive indices of hepatic damage. Earlier study states that bittergourd juice can also prevent jaundice by

strengthening the liver [31]. Fraction MCK3 administration led to a significant decrease in ALP and total bilirubin levels. Our results too indicate that MCK3 has its protective role over liver and improvements in liver efficiency and could be helpful against hepatocellular damage which is found in Type – I diabetes. Fraction MCK3 had slightly but significantly increased the total protein and albumin in the blood of treated Type – I diabetic rats. Our results essentially matched with earlier study [32] which reported the higher total protein levels in blood of diabetic animals when treated with acetone extract of *Momordica charantia L.* fruits [33]. Similarly stimulation of protein biosynthesis in rat hepatocytes by MC extracts was reported [34]. Earlier studies observed that serum protein concentrations can be affected by impaired kidney functions in diabetes, thus, our observation further substantiate the recent findings [35].

**TABLE 2:** Determination of the optimum dose of fraction MCK3 for hypoglycemic activity in Type – I diabetic animals.

| Period (hr) of treatment | 0 | 3 | Reduction % |
|---|---|---|---|
| Saline Treated Normal Control Rats | 90 ± 10 | 86 ± 11 | 4.6 |
| Saline Treated Diabetic Control Rats | 414 ± 16.5 | 428 ± 18.7 | 3.27 |
| MCK3 (5 mg/kg b.wt.) Treated Diabetic Rats | 436 ± 37.0 | 344 ± 9* | 26.74 |
| MCK3 (10 mg/kg b.wt.) Treated Diabetic Rats | 401 ± 13.8 | 300 ± 17.1*** | 33.66 |
| MCK3 (15 mg/kg b.wt.) Treated Diabetic Rats | 521 ± 34.3 | 285 ± 21.7*** | 82.80 |
| MCK3 (20 mg/kg b.wt.) Treated Diabetic Rats | 537 ± 39.0 | 296 ± 21.0*** | 81.41 |
| MCK3 (25 mg/kg b.wt.) Treated Diabetic Rats | 534 ± 16.1 | 442 ± 13.0 | 20.81 |
| Insulin (5 IU/kg b.wt.) Treated Diabetic Rats | 506 ± 19.8 | 282 ± 16.5 | 79.43 |
| Proteinase-K + MCK3 (15 mg/kg b.wt.) Treated Diabetic Rats | 414 ± 32.4 | 378 ± 39.1 | 9.5 |

Diabetic animals were treated with different doses of fraction MCK3 (0.5 ml). Blood glucose (mg/dL) was measured before and 3 h post-administration. Saline- treated normal and diabetic animals were included as controls. Protamine zinc insulin-treated animals were included as positive controls. The data represent mean ± S.E. Each group consisted of at least 5-6 animals. *P < 0.05; ***P < 0.001, compared with the respective group at 0 hr.

**TABLE 3:** Effect of prolonged MCK3 treatment on blood glucose levels in Type – I diabetic rats.

| Period (days) of treatment | 0 | 4 | 8 | 12 | 16 | 20 |
|---|---|---|---|---|---|---|
| Saline Treated Normal Rats | 83.4 ± 8.3 | 81 ± 6.4 | 83 ± 7.2 | 85 ± 7.7 | 87 ± 7.7 | 88 ± 7.6 |
| Saline Treated Diabetic Rats | 407 ± 73 | 491 ± 42 | 5.6 ± 47 | 467 ± 44 | 456 ± 67 | 543 ± 80 |
| MCK3 Treated Diabetic Rats | 367 ± 106 | 250 ± 98** | 240 ± 68** | 238 ± 77** | 210 ± 55** | 189 ± 66*** |
| Insulin Treated Diabetic Rats | 418.92 ± 23 | 334.2 ± 61** | 346.8 ± 70 | 285.4 ± 46*** | 263.9 ± 47*** | 255.3 ± 8*** |

Diabetic animals ($n$ = 6) were administered with saline, MCK3 (15 mg/kg b.wt.) and protamine zinc insulin (5 IU/kg b.wt.) once daily. Blood glucose levels (mg/dL) were measured on the days indicated. Control diabetic animals ($n$ = 10) were treated with equal volume of saline (0.5 ml). The data represent mean ± S.E. $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$, compared with blood glucose levels on 0 day.

**TABLE 4:** Effect of fraction MCK3 on Lipid Profile in Type – I diabetic rats

| **Group No.** | **Treatment (Intraperitionial)** | **Biochemical parameters** | | | | | |
|---|---|---|---|---|---|---|---|
| | | Total Cholesterol (TC) mg/dl | Triglyceride (TG) mg/dl | HDL (mg/dl) | LDL (mg/dl) | VLDL (mg/dl) | Atherogenic Index (units) |
| 1. | Normal control + Saline (0.5 ml) (6) | 138.52±12.33 | 75.51±4.59 | 54.94±2.11 | 71.68±13.83 | 15.10±0.92 | 1.5±0.10 |
| 2. | Diabetic control + Saline (0.5 ml) (6) | 226.78±8.58 | 110.5±11.40 | 43.57±2.87 | 160.19±7.04 | 22.10±2.28 | 4.27±0.29 |
| 3. | Diabetic + Insulin (5U/kg BW) | 136.34±9.45* | 98.19±5.70 | 44.76±2.19 | 80.28±9.02* | 19.64±1.14 | 2.09±0.28 |
| 4. | Diabetic + Fraction $MCK_3$ (15 mg/kg BW) | 128.50±7.45* | 80.88±4.00* | 46.61±1.15* | 69.09±15.44* | 16.18±0.80* | 1.74±0.09* |

Diabetic animals were injected with fraction $MCK_3$ (15 mg/kg BW, i.p.). Control animals received equal volume of saline. Animals were killed; 3 h after injection of test sample and serum was separated from freshly collection blood, and tissues, which are subjected to various biochemical analyses. The values represent the mean ± S.E. for the number (n) of animals in parenthesis. *p≤0.05, **P≤0.01

**TABLE 5:** Effect fraction MCK3 on Liver Function Tests (LFTs) in Type - I diabetic rats

| Treatment (Intraperitonial) | Biochemical parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | **AST (U/1)** | **ALT (U/1)** | **GGT (U/1)** | **ALP (U/1)** | **BIL-T (mg/dl)** | **TP (g/dl)** | **ALB (g/dl)** |
| Normal control + Saline (0.5 ml)(6) | 65.8±3.8 | 38.8±2.4 | 54±2.5 | 78.2±5.2 | 0.5±0.1 | 7.0±1.3 | 4.5±1.0 |
| Diabetic control + Saline (0.05 ml)(6) | 143.6±5.5 | 166±3.34 | 89.29±2.28 | 120.6±8.6 | 2.0±0.1 | 5.9±0.108 | 3.56±0.147 |
| Diabetic + Fraction $MCK_3$ (15 mg/kg BW)(6) | 133.7±6.1* | 143±2.81* | 59.75±1.48* | 99.6±7.8** | 1.4±0.1* | 7.3±0.114* | 4.4±0.132* |

Diabetic animals were injected with fraction $MCK_3$ (15 mg/kg BW, i.p.). Control animal received equal volume of saline. Animals were killed; 3h after injection of test sample and serum was separated from freshly collection blood, and tissues, which are subjected to various biochemical analyses. The values represent the mean ± S.E. for the number (n) of animals in parenthesis. *p≤0.05, **P≤0.01

## IV. Conclusion

The hypoglycemic principle(s) present in fraction MCK3 of bittermelon (*Momordica charantia Linn.*) is able to alleviate dyslipidemia and hepatic damage caused by alloxan – diabetes and have brought nearly normal normolipidemic and hepatoprotective status in Type – I diabetic rats.

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