WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 12, Issue 7, 15-28 Research Article SSN 2277– 7105

# MODULATORY POTENTIAL OF CHROMIUM SUPPLEMENTATION ON GLUCOSE, LIPID PROFILE AND LIPID PEROXIDATION OF ALLOXAN-INDUCED DIABETIC WISTAR RATS

**Bunza, Jafaru Muhammad[1]*, Dallatu M. K.[1], Bilbis L. S.[2], Shehu B.[3], Alhassan A. J.[4], Leje I. M.[1], Ngaski A. A.[1], Jidda Muhammad Lawal[1], Kakako S. Ladipo[1], Yale B. M.[1], Kasimu Maryam[1], Haruna S.[5], Ogunwale K. A. and Ibrahim Kalle Kwaifa[6]**

[1]Department of Chemical Pathology, School of Medical Laboratory Sciences, Usmanu Danfodiyo University, Sokoto.

[2]Department of Biochemistry, Faculty of Sciences, Usmanu Danfodiyo University, Sokoto.

[3]Department of Biochemistry, Faculty of Allied Health Sciences, Bayero University, Kano.

[4]Department of Medical Laboratory Sciences, Faculty of Allied Health Sciences, Ahmadu Bello University, Zaria.

[5]Department of Chemical Pathology and Immunology, University of Ilorin Teaching Hospital, Ilorin.

[6]Department of Haematology, School of Medical Laboratory Sciences, Usmanu Danfodiyo University, Sokoto.

Article Received on
07 March 2023,

Revised on 28 March 2023,
Accepted on 19 April 2023

DOI: 10.20959/wjpr20237-27560

***Corresponding Author**
**Bunza, Jafaru Muhammad**
Department of Chemical Pathology, School of Medical Laboratory Sciences, Usmanu Danfodiyo University, Sokoto.

## ABSTRACT

Chromium (Cr) appeared to be one of the most promising elements in the therapeutic management of diabetes mellitus. The objective of this current study is to identify the modulatory activities of Cr on body mass index (BMI), fasting levels of blood glucose, lipid profiles and malondialdehyde (MDA) (a product of lipid peroxidation) in alloxan-induced diabetic Wistar rats. In this study, twenty-eight rats were randomly divided into four groups containing equal numbers of rats. The first group was labelled as the non-diabetic control. The second group was labelled as the diabetic control group. The third and fourth groups were diabetic groups, orally administered with 80µg/kg/day Cr and 70mg/kg/day metformin respectively. Rats weight and glucose level were determined at 1st week before dosing and at 4th week

before sacrifice. On day 30, blood was collected and used for biochemical analysis. These results showed that supplementation with Cr significantly ($p<0.05$) altered fasting blood glucose level, but does not affect BMI of diabetic rats. The mean concentration of total cholesterol (TC) (5.32±0.37) mmol/l, Triglycerides (TG) (1.47±0.13) mmol/l, low-density lipoprotein-cholesterol (LDL-C) (3.44±0.46) mmol/l and Atherogenic index (AI) (4.62±0.60)mmol/l were significantly lowered ($p<0.05$) in Cr supplemented diabetic rats compared to the diabetic control group (9.17±0.91, 3.10±0.52, 6.82±1.08 and 10.65±1.23) respectively. The difference between mean concentrations of very low-density lipoprotein-cholesterol (VLDL-C) (0.29±0.03) mmol/l and high-density lipoprotein-cholesterol (HDL-C) (1.21±0.09) mmol/l of the diabetic rats supplemented with Cr and that of diabetic controls (0.48±0.11) and (1.01±0.16) respectively were statistically insignificant ($p>0.05$). The mean MDA concentration was lowered significantly ($p<0.05$) in Cr supplemented group ($2.1\times10^{-6}\pm1.5\times10^{-7}$) nmol/ml than in diabetic control group ($3.2\times10^{-6}\ \pm4.7\times10^{-7}$) nmol/ml. In conclusion, the results projected above, serves as a hint towards the development of therapeutic strategies aimed at Cr manipulation for protection from hyperglycaemia and dyslipidaemia.

**KEYWORDS**: Chromium, malondialdehyde, hyperglycaemia, dyslipidaemia.

## 1.0 INTRODUCTION

Diabetes mellitus (DM) is a typical metabolic disorder personified by hyperglycaemia as a result of a complete or comparable insulin deficiency. Diabetes affects key biochemical pathways in the body including carbohydrate, protein, and lipid metabolisms. A World Health Organization (WHO}[1] report in 2008, gave an approximation that over 171 million individuals globally are diabetic, and this number is projected to be on the rise by over a 100% to 366 million by 2030. DM affects the metabolism of micronutrients including Chromium, which is a vital mineral believed to be required for normal glucose and lipid homeostasis.[2] Chromium (Cr) is basically exists in two forms: the first form is the biologically active, non-toxic Trivalent (Chromium III), that is found in food, the second form is the hexavalent (chromium VI), which is the toxic form of chromium, which has its origins from industrial pollution. The Trivalent chromium, believed to be the biologically active form of chromium, is a glucose tolerance factor and.[3] The most commonly used Trivalent chromium formulations are, chromium nicotinate, chromium picolinate and Chromium chloride, with the picolinate formulation specially developed to enhance

absorption.[2] Through insulin activation, chromium can significantly increase enzyme activity and plays a critical role in metabolism of carbohydrates, stimulating the liver to synthesize fatty acid and cholesterol from acetate, and improved metabolism of sugar. Furthermore, chromium renders the body tissues to be more responsive to insulin.[4] Reversible insulin resistance and DM can be triggered by severe chromium deficiency. However, the effect of supplementation with chromium on subjects without severe chromium deficiency remains unclear. The pharmacological treatment of MD includes biguanide.[5] Metformin is an anti-hyperglycaemic agent belonging to the biguanides family and is the initial drug of choice for the treatment of type 2 DM patients. Metformin is a safe drug having numerous physiological and molecular effects linked to minimal toxicity. Metformin lowers hyperglycaemia through the reduction of intestinal glucose absorption, it raises the peripheral tissues glucose absorption and triggers pancreatic beta-cells to secrete insulin.[6] Metformin acutely reduces glucose output by the liver, suppresses gluconeogenesis by increasing secretion of insulin and energy supply reduction via AMP-activated protein kinase (AMPK) activation, by inhibiting the respiratory-chain complex 1 of the mitochondria with a resultant rise in nicotinamide adenosine dihydrogen phosphates (NADH) oxidation followed by a subsequent reduction in Adenosine Triphosphate (ATP) synthesis. Metformin also promotes muscular cells uptake of glucose, thus lowering the fasting levels of blood glucose in Type2 DM subjects.[7] Metformin also regulates the indirect inhibition of expression of receptors of insulin and tyrosine kinase activity, and strengthening sensitivity of insulin and a reduction in diabetic subject insulin resistance.[8] This study was conceived and designed to determine the effect of Cr supplementation and metformin on serum lipoid profile and Malondialdehyde in Diabetic Rats.

## 2.0 MATERIALS AND METHODS

Twenty-eight (28) Wistar-albino rats with an average weight between 150 - 220g were purchased from the Animal House of the Faculty of Pharmaceutical Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria. The rats were housed and allowed to acclimatize under related conditions at temperatures between 32 ± 4$^{o}$C, with a 12-hour light/dark cycles, in standard cages at the animal house, Pharmacology Department, Faculty of Pharmaceutical Sciences, Usmanu Danfodiyo University, Sokoto. The animals are fed with standard pelletized growers' feed and allowed free access to water *ad libitum.*[9]

### *A. Grouping of Animals*

The rats were arbitrarily split up into 4 groups of seven rats each and numbered from I - IV:

Group I: Non-diabetic rats as control

Group II: Diabetic Wistar rats only

Group III: Diabetic Wistar rats with chromium supplementation

Group IV: Diabetic Wistar rats with metformin therapy

For the induction of diabetes for the experiment, Alloxan monohydrate was dissolved in Normal saline solution (0.9% sodium chloride) at a pH 7. The Alloxan solution was given as a 150 mg/kg intraperitoneal single dose injection to the Wistar rats using a diabetic syringe as recommended by[10], then placed on a 10% glucose in drinking water for next the 24 hours to prevent overt hypoglycaemia.[11] After 72 hours fast, their fasting level of blood glucose (FBG) was measured using Call Plus (Acon Laboratories one touch glucometer).[12] Wistar rats having a fasting glucose level >180 mg/dl were believed to be diabetic. Their glucose levels are then assayed weekly to assess their chromium supplementation effects on glucose. Diabetic rats (group III) were supplemented with 80µg/kg/day of Cr dissolved in distilled water, administered orally by intubations for 4 weeks.[13] Metformin treatment (70mg/kg of body weight) was administered to group IV orally one time daily for 4 weeks.[14] On the 28$^{th}$ day of the treatment, the animals were then made to fast overnight, then every rat was individually dropped into a plastic transparent jar saturated with chloroform vapour to be anaesthetized. About 5 ml of blood sample was then collected by cardiac puncture and the collected sample was divided into plain container and a fluoride oxalate container for analysis. Human procedure was used throughout the experiment.[15] Ethical clearance was sought and approval given by UDUS ethics and research committee. The BMI of each rat was calculated using the following expression:

$$\text{Body mass index } (g/cm^2) = \text{Body weight } (g) / \text{Body length } (cm^2).$$

Plasma glucose was determined using glucose oxidase/peroxidase method.[16] The total cholesterol in serum was estimated using an enzymatic colorimetric method as reported by Richmond.[17] The serum HDL-C was determined using enzymatic colorimetric method.[18] Low density lipoprotein was calculated using the formulae by.[19] LDL-C = TC— (HDL-C + TG/2.2) *mmol/l*, VLDL-C was also calculated using the formulae by.[19] VLDL-C = TG/5*(mmol/l)*. The serum TG concentration was estimated by enzymatic colorimetric method.[20] The AI was computed as the ratio of total cholesterol to HDL-cholesterol.[21] AI =

TC/HDL-C, MDA which is a lipid peroxidation product was evaluated using the TBARS assay (Thio-Barbituric Acid Reactive Substance).[22]

### 2.2 *Statistical Analysis*

Data obtained are presented as mean ± standard error of mean (SEM). The data was then analysed using (ANOVA) to determine statistically significant values, Tukey's *post-hoc test* was used to compare the statistically significant values between the control and experimental groups. All the statistical analysis was evaluated using SPSS version 25.0 software. All p-values ($p \leq 0.05$) were considered to be of statistical significance.

## 3.0 RESULTS

Table 4.1 Shows changes in BMI of diabetic Wistar rats that have been treated with chromium supplementation, on metformin therapy and control. The final BMI of group II value of (0.44±0.03) g/cm$^2$ is lowered significantly ($p<0.05$) in contrast to the initial (0.61±0.04) g/cm$^2$. The difference between the final BMI and initial of controls and groups supplemented with Cr and metformin were insignificant statistically ($p>0.05$). Table 4.2 shows the effect of chromium supplementation on blood glucose concentration of diabetic rats and control. Induction of type 1 diabetic state caused a statistically significant surge in blood glucose concentration in contrast to non-diabetic controls ($p<0.05$). The Cr supplementation decreased blood glucose concentration significantly after 4 weeks ($p<0.05$). The fasting blood glucose concentrations of group II (19.75±75) mmol/l is significantly high ($p<0.05$) when compared to that of controls (4.32±0.14) mmol/l. There was no established statistically significant difference ($p>0.05$) between group III (6.58±0.35) mmol/l and group IV (5.17±0.28) mmol/l compared with to the control group.

**Table 4.1: Changes in Body Mass Index of Diabetic Wistar Rats supplemented with Chromium and Controls.**

| Groups | N | Initial BMI(g/cm$^2$) | Final BMI (g/cm$^2$) |
|---|---|---|---|
| Group I | **7** | 0.41±0.01 | 0.44±0.01 |
| Group II | **7** | 0.61±0.04 | 0.44±0.03 |
| Group III | **7** | 0.31±0.02 | 0.35±0.02 |
| Group IV | **7** | 0.40±0.02 | 0.41±0.02 |
| P value | | <0.05 | <0.05 |
| **Post hoc test** | | | |
| Group I Vs II | | <0.05 | >0.05 |
| Group I Vs III | | >0.05 | <0.05 |
| Group I Vs IV | | >0.05 | >0.05 |

| | | | |
|---|---|---|---|
| Group II Vs III | | <0.05 | <0.05 |
| Group II Vs IV | | <0.05 | >0.05 |
| Group III Vs IV | | >0.05 | >0.05 |

Values are expressed as mean ± SEM, N= number of rats; Group I = Normal control; Group II = Diabetic control; Group III= Diabetic group supplemented with chromium picolinate 80µg/kg body weight; Group IV= Diabetic group supplemented with metformin 70mg/kg body weight.

**Table 4.2: Effects of Chromium supplementation on Fasting Blood Glucose of Diabetic Wistar Rats and Controls.**

| **Groups** | **N** | **Initial fasting glucose before dosing (mmo/l)** | **Final fasting glucose before sacrifice (mmol/l)** |
|---|---|---|---|
| Group I | 7 | 4.70±0.14 | 4.32±0.14 |
| Group II | 7 | 20.00±2.67 | 19.75±2.26 |
| Group III | 7 | 18.20±1.86 | 6.58±0.35 |
| Group IV | 7 | 17.98±1.77 | 5.17±0.28 |
| P value | | <0.05 | <0.05 |
| **Post hoc test** | | | |
| Group I Vs II | | <0.05 | <0.05 |
| Group I Vs III | | <0.05 | >0.05 |
| Group I Vs IV | | <0.05 | >0.05 |
| Group II Vs III | | >0.05 | <0.05 |
| Group II Vs IV | | >0.05 | <0.05 |
| Group III Vs IV | | >0.05 | >0.05 |

Values are expressed as mean ± SEM, N= number of rats; Group I = Normal control; Group II = Diabetic control; Group III= Diabetic group supplemented with chromium picolinate 80µg/kg body weight; Group IV= Diabetic group supplemented with metformin 70mg/kg body weight.

Table 4.3 shows chromium supplementation effects of and metformin therapy on fasting lipid profile in diabetic Wistar rats. Induction of type 1 diabetic state results in a statistically significant increase ($p<0.05$) in TC (9.17±0.91)mmol/l, TG (3.10±0.52)mmol/l, LDL (6.82±1.08)mmol/l and AI (10.65±1.72)mmol/l compared to non-diabetic control group (4.68±0.37, 1.61±0.08, 2.80±0.39 and 4.03±0.33)mmol/l respectively. VLDL of diabetic rats is insignificantly ($p>0.05$) higher (0.48±0.11)mmol/l relatively to control group (0.33±0.02)mmol/l whereas, HDL of diabetic rats is statistically insignificantly ($p>0.05$) lower (1.01±0.16)mmol/l when compared to that of the control group (1.15±0.05)mmol/l. In relation to diabetic untreated group, Cr supplementation in group III and metformin therapy in group IV shows a significant decline ($p<0.05$) in TC, TG, LDL and AIX, with an

insignificant decrease ($p>0.05$) in VLDL and insignificant ($p>0.05$) rise in HDL were also observed. There is no statistically significant ($p>0.05$) difference between the means of TC, TG, LDL, VLDL, and AIX of group III and IV when compared to that of controls. The HDL of group III however, shows a moderate increase which has no statistical significance ($p>0.05$).

Table 4.4, this table shows the effect of chromium supplementation and metformin therapy on MDA of diabetic group and control group. MDA of group II ($3.2\times10^{-6}\pm4.7\times10^{-7}$) nmol/ml is significantly high statistically ($p<0.05$) when compared to that of controls ($2.0\times10^{-6}\pm3.7\times10^{-7}$) nmol/ml. The Cr supplementation in group III and metformin therapy in group IV shown significantly ($p<0.05$) lowered MDA concentration ($2.1\times10^{-6}\pm1.5\times10^{-7}$) nmol/ml and ($1.9\times10^{-6}\pm1.8\times10^{-7}$) nmol/ml respectively compared with group II. With the exception of group II vs IV, no statistically significant difference ($p>0.05$) was recorded between the two groups.

**Table 4.3: Effects of Chromium supplementation on Fasting Lipid Profile of Diabetic Wistar rats and Controls.**

| Groups | N | TC (mmol/l) | TG (mmol/l) | HDL-C (mmol/l) | LDL-C (mmol/l) | VLDL-C (mmol/l) | AI (mmol/l) |
|---|---|---|---|---|---|---|---|
| Group I | 7 | 4.68±0.37 | 1.61±0.08 | 1.15±0.05 | 2.80±0.39 | 0.33±0.02 | 4.03±0.33 |
| Group II | 7 | 9.17±0.91 | 3.10±0.52 | 1.01±0.16 | 6.82±1.08 | 0.48±0.11 | 10.65±1.72 |
| Group III | 7 | 5.32±0.37 | 1.47±0.13 | 1.21±0.09 | 3.44±0.46 | 0.29±0.03 | 4.62±0.64 |
| Group IV | 7 | 5.18±0.53 | 1.43±0.05 | 1.05±0.06 | 3.47±0.51 | 0.28±0.01 | 4.95±0.45 |
| P value | | <0.05 | <0.05 | >0.05 | <0.05 | >0.05 | <0.05 |
| **Post hoc test** | | | | | | | |
| Group I Vs II | | <0.05 | <0.05 | >0.05 | <0.05 | >0.05 | <0.05 |
| Group I Vs III | | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 |
| Group I Vs IV | | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 |
| Group II Vs III | | <0.05 | <0.05 | >0.05 | <0.05 | >0.05 | <0.05 |
| Group II Vs IV | | <0.05 | <0.05 | >0.05 | <0.05 | >0.05 | <0.05 |
| Group III Vs IV | | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 |

Values are expressed as mean ± SEM, N= number of rats; Group I = Normal control; Group II = Diabetic control; Group III= Diabetic group supplemented with chromium picolinate 80µg/kg body weight; Group IV= Diabetic group supplemented with metformin 70mg/kg body weight.

**Table 4.4: Effects of Chromium supplementation on Malondialdehyde of Diabetic Wistar rats and Controls.**

| Groups | N | MDA (nmol/ml) |
|---|---|---|
| Group I | 7 | $2.0\times10^{-6}\pm3.7\times10^{-7}$ |
| Group II | 7 | $3.2\times10^{-6}\pm4.7\times10^{-7}$ |
| Group III | 7 | $2.1\times10^{-6}\pm1.5\times10^{-7}$ |
| Group IV | 7 | $1.9\times10^{-6}\pm1.8\times10^{-7}$ |
| P value | | <0.05 |
| **Post hoc test** | | |
| Group I Vs II | | >0.05 |
| Group I Vs III | | >0.05 |
| Group I Vs IV | | >0.05 |
| Group II Vs III | | >0.05 |
| Group II Vs IV | | <0.05 |
| Group III Vs IV | | >0.05 |

Values are expressed as mean ± SEM, N= number of rats; Group I = Normal control; Group II = Diabetic control; Group III= Diabetic group supplemented with chromium picolinate 80µg/kg body weight; Group IV= Diabetic group supplemented with metformin 70mg/kg body weight.

## DISCUSSION

Alloxan is a drug commonly employed for experimental diabetes induction due to its cautious approach of selectively targeting and destroying pancreatic beta cells responsible for the production of insulin.[23] When administered to the experimental rats, Alloxan bring about a blood glucose response that is multiphasic, which is followed by an equivalent counter changes in the insulin plasma concentrations, that is usher in a serial ultra-structural beta cell changes that will ultimately lead to cell death by necrosis. The first phase is transient hypoglycaemic phase that can lasts for a maximum period for 30 minutes. The second phase appears, usually an hour after the administration of alloxan, and usually leads to a rise in the blood glucose concentration of the experimental animals. The hyperglycaemic phase normally lasts for between 2-4 hours which can be accompanied by a decrease in Insulin concentration in plasma. The third phase is characterised again by hypoglycaemia that is noticed within 4-8 hours of alloxan administration.[10] The fourth phase, which is the last and final permanent diabetic hyperglycaemic phase is characterized by total degranulation and loss of beta cells integrity within 24-48 hours after alloxan administration.[24] Furthermore, various researchers have reported a decrease in the level of insulin in alloxan induced diabetic rats.[25-27]

## 4.0 BODY MASS INDEX AND FASTING GLUCOSE OF DIABETIC WISTAR RATS

In this current study, Cr supplementation significantly decreased blood glucose levels ($p<0.05$) in diabetes induced Wistar rats but no affect was recorded on body mass index. This was in agreement with the results of Muhammad *et al.*,[28], who recorded in an earlier study titled the effect of chromium on glucose and lipid profiles in patients with type 2 diabetes; which is A meta-analysis review of randomized Trials. Another study by Rabinovitz *et al* demonstrated the useful effects derived by type 2 diabetic patients from Cr supplementation. Chromium ingestion of 200µg, two times in a day for a period of three weeks, will bring about changes in levels of fasting blood glucose when compared to the baseline.

## 5.0 FASTING LIPID PROFILE OF DIABETIC RATS

In this present study, induction of Alloxan in rats caused a significant rise ($p<0.05$) in levels of TC, TG, LDL and AI, while VLDL-C was significantly ($p>0.05$) decreased in comparison to the controls. On the other hand, HDL-C is insignificantly reduced ($p>0.05$) relatively to normal control group. Chromium supplementation significantly reduced TC, TG, LDL, VLDL and AIX, and significantly decreased in HDL-C levels. This result is similar with the previous report by[2], that documented the beneficial effects of supplementation of chromium on blood glucose concentration, haemoglobin A1C levels, lipid profile tests and lipid peroxidation on type 2 DM patients. Rabinovitz *et al* in his research shows the benefits derived from chromium supplementation in type 2 diabetes, where they showed that chromium consumption of around 200µg twice daily for three weeks can bring about reduction in TC levels from 235mg/dL to 213mg/dL ($p<0.02$). A shift towards a lower TG concentration from (152mg/dL to 136mg/dL) was noticed.[2] However, this result disagreed with the report made by.[29], who assesses supplementation with chromium (i.e of 200µg trivalent chromium once daily for 6 weeks) effects on insulin response and glucose tolerance on long-term control diabetes and serum lipid of 10 non-insulin dependent diabetics, aged between 37 and 68 years. The current study is also in contrast with reports from a study by[28], who reported no beneficial effects from supplementation with chromium on plasma lipids. The variations noticed in the numerous studies may be ascribed to either duration of studies, the type of chromium ion administered, the status of chromium in the individual subjects, and the level of glucose intolerance.[30] Faten and Zaki,[13] also reported a decrease in fasting glucose of diabetic rats in his study. However, this study is not in agreement with the reports[31], who assessed the effects of trivalent chromium supplements on blood glucose levels both diabetics and normal individuals administered with a 50µg of trivalent chromium

and a chromium-placebo thrice daily orally for a 16 weeks period. The variation noticed in several studies maybe credited to study duration, the type of chromium used, chromium status of individual patients and the glucose intolerance levels of the subjects.[30] The biochemical mechanism which allows CrPic to amplify cholesterol homeostasis has been investigated. CrPic has been noted to activate 5′-adenosine monophosphate (AMP) – activated protein kinase (AMPK), which makes AMPK the crucial signal that causes decreased lipogenesis and fatty acid oxidation as a result of modulation caused by chromium picolinate. Previous studies conducted have shown that chromium picolinate upregulated the activity of the binding protein in sterol regulatory element, and is responsible for controlling the cellular level of cholesterol balance. The protein regulatory factor is membrane bound and therefore it is presumed that chromium supplementation causes a decline in plasma membrane cholesterol. All of these responses are indications of the significant effect chromium has on cholesterol homeostasis.[32] The biochemical mechanism permitting chromium to amplify the actions of insulin receptors on cell membranes have been thoroughly investigated. It is now suggested that a low molecular weight octapeptide (LMWCr, intracellularly located), also referred to as chromadulin, binds $Cr^{+3}$ and enhances insulin receptors response.[33] Chromadulin proposed mode of action is (1) the conversion of cell membranes inactive insulin receptors to an active form by binding circulating insulin; (2) this binding stimulates the movement of chromium into cells bound to plasma transferrin; (3) the chromium will then bind to apoLMWCr, converting it to an active form which will then bind to receptors of insulin and results into amplification of the kinase activity; (4) as the plasma insulin and glucose levels drops to normoglycaemic levels, the LMWCr factor will then dissociate from the cell thereby terminating its effects.[33]

## 6.0 MALONDIALDEHYDE OF DIABETIC WISTAR RATS

In the current study, chromium supplementation significantly ($p<0.05$) reduces malondialdehyde level ($2.1\times10^{-6}$ $\pm1.5\times10^{-7}$) nmol/ml when compared to diabetic control group ($3.2\times10^{-6}$ $\pm4.7\times10^{-7}$) nmol/ml. This study disagreed with the finding of.[34] who scrutinized the possible connection existing between serum chromium levels and MDA in type 2 diabetic patients, and did not find any relationship linking serum malondialdehyde and chromium levels in type 2 diabetic patients, despite a decline in serum chromium concentrations and a rise in serum MDA level of diabetic patient. The disparities observed in this study may be ascribed to study duration, type of chromium used, the chromium dose and individual chromium status.[30] Perhaps, their studies were conducted on Human with type 2

diabetes. MDA, are highly toxic by-products of free lipid radicals formed through lipid oxidation, and studies have shown that its concentrations are significantly raised in DM. MD can proceed both reversibly and irreversibly with proteins and phospholipids with extreme effects.[35]

## CONCLUSION

The findings of this present study, shown that administration of Alloxan at 150mg/kg bod weight significantly increased the glucose level, while administration of chromium on diabetic rats did not show significant effect on BMI but significantly reduced blood glucose level. The TC, TG, AIX and LDL of diabetic rats reduced significantly after chromium supplementation, while statistically significant reduction on VLDL and HDL-C levels of the diabetic rats were recorded. Administration of chromium would be utilized as potential therapeutic supplement on DM.

## ACKNOWLEDGMENT

We acknowledged the contribution of all the participating, who contributed massively during the course of this research.

## FUNDING

The research was self-sponsored, dedicated by the participating authors.

## CONFLICT OF INTEREST

Authors declare no conflict of interest.

## REFERENCES

1. World Health Organization. Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Report of a WHO Consultation, 1999; 2.
2. Nayereh P, and Hassan MK. Effect of Chromium supplementation on Blood glucose, Hemoglobin A1C, Lipid profile and Lipid peroxidation in Type 2 Diabetic patients. *Iranian Journal of Diabetes and Obesity, 2013;* 4(4): 178-184.
3. Bruna M, and Ramiro BN. Effects of Chromium Picolinate supplementation on Control of Metabolic Variables: A Systemic Review. *Journal of Food and Nutritional Research,* 2016; 4(10): 633-639. DOI:10.12691/jfnr-4-10-1.
4. Falah SA, and Saja NM. Essential Trace Elements and their vital roles in Human body. *Indian Journal of Advances in Chemical Science*, 2017; 5(3): 127-136.

5. Kupsal K, Mudigonda S, Nyayapathi NK, and Hanumanth SR. Metformin combinatorial therapy for Type 2 Diabetes Mellitus. *Journal of Metabolic Syndrome,* 2016; 5: 210-215.
6. Viollet B, Guigas B, Garcia NS, Leclerc J, and Foretz M. Cellular and molecular mechanisms of metformin: an overview. *Clinical Science,* 2012; 122: 253-270.
7. Pryor R, and Cabreiro F. Repurposing metformin: an old drug with new tricks in its binding pockets. *Biochemistry Journal,* 2016; 471: 307-322.
8. Riedmaier AE, Fisel P, Nies AT, and Schwab M. Metformin and Cancer: From old medicine cabinet to pharmacological pitfalls and Prospects. *Trends of Pharmacological Scienc,* 2013; 34: 126-135.
9. Lawal N, Idoko AS, and Sullubawa AZ. Serum glucose, lipid profile and oxidative stress markers of salt-induced metabolic syndrome rats administered antioxidant rich nutraceutical. *International Journal of Biochemistry Research and Review, 2016;* 10(3): 1-7.
10. Ajibola M, Eunice O, and Stephanie IN. Effects of Aqueous Extract of *Moringa oleifera* Seeds on Alloxan Induced Hyperglycemia. *Basic Sciences of Medicine, 2014;* 3(3): 37-42.
11. Misra M, and Aiman U. Alloxan: An unpredictable drug for diabetes induction. *Indian Journal of Pharmacology, 2012;* 44(4): 538-539.
12. Anees M, Jawad A, and Hashmi I. Distribution of ABO and RH Blood Group Alleles in man Bahauddin District of Punjab, Pakistan Proc. *Journal of Pakistan Academic Science, 2007;* 144: 289-294.
13. Faten AM, and Zaki AA. Modulatory Activity of Zinc and/or Chromium on Mitogenesis of Lymphocytes of Streptozotocin-induced Diabetic Rats. *International Journal of Food, Agriculture and Veterinary Science,* 2014; 4(3): 39-49.
14. Siwei Z, Huali X, Wu Y, and Sui D. Metformin ameliorate diabetic nephropathy in a rat model of low-dose STZ-induced diabetes. *Advance Journal of Experimental and Therapeutic Medicine, 2017;* 14(1): 383-390.
15. Dallatu MK, Anaja PO, Bilbis LS, and Mojiminiyi FBO. Antioxidant micronutrient potential in strengthening the antioxidant defences in alloxan-induced diabetic rats. *Nigeria Journal of Pharmaceutical Sciences, 2009;* 8(1): 89-94.
16. Trinder P. Determination of blood glucose in blood using glucose oxidase with an alternative oxygen acceptor. *Annals of Clinical Biochemistry, 1969;* 6: 24-25.
17. Richmond W. Determination of Serum Cholesterol. *Scandinavian Journal of Clinicaland Laboratory Investigation, 1972;* 29: 126-127.

18. Burstein M, Scholnick HR, and Morfia R. Rapid Method for the Isolation of Lipoproteins from Human Serum by Precipitation with Polyanions. *Scandinavian Journal of Clinical and Laboratory Investigation, 1980;* 40: 583-595.
19. Friedewald W, Levy RI, and Friederickson DS. Estimation of the concentration of Low-Density Lipoprotein Cholesterol in Plasma without the use of Preparative Ultra centrifuge. *Clinical Chemistry, 1974;* 18(6): 499-502.
20. Bucola D, and David H. Determination of Triglycerides. *Clinical Chemistry, 1973;* 19: 476-477.
21. Murray R, Granner D, Mayes P, and Rodwell V. *Harpers Biochemistry.* 24th ed. USA. 1996; Prentice Hall International.
22. Shah JK, and Walker's AM. Quantitative determination of MDA. *Biochemica et Biophysica Acta,* 1989; 11: 207-211.
23. Szkudelski T. The mechanism of action of Alloxan and streptozocin action in beta cells of the Rat pancreas. *Physiological Research, 2001;* 50: 536-546.
24. Mythili MD, Vyas R, Akila G, and Gunasekaran S. Effects of streptozotocin on the ultra-structure of rat pancreatic islets. *Microscopy Research and Technique,* 2004; 63: 274-281.
25. Adewole SO, and Martins EAC. Morphological Changes and Hypoglycemic Effects of *Annona MuricataLinn. (Annonaceae)* Leaf Aqueous Extract on Pancreatic β-cell of Stz Treated DiabeticRats. *African Journal of Biomedical Research, 2006, 9*: 173-187.
26. Gupta R, Mathur M, Bajaj VK, Katariya P, Yadav S, Kamal R, and Gupta RS. Evaluation of anti-diabetic and antioxidant activity of *Moringa oleifera* in experimental diabetes. *Journal of Diabetes, 2012;* 164-171.
27. El-Desouki NI, Tabl GA, Abdel –Aziz KK, Salim EI, and Nazeeh N. Improvement in beta-islets of Langerhans in alloxan-induced diabetic Rats by Erythropoietin and Spirulina. *Journal of Basic & Applied Zoology, 2015;* 6(3): 642.
28. Mohammad A, Amir F, shekoufeh N, and Meysam S. Effect of chromium on glucose and lipid profiles in patient with type2 diabetes; A Meta-analysis review of Ramdomized Trials. *Journal of Pharmacology and Pharmaceutical Science, 2013;* (www.cspsCanada.org), 16(1): 99-144.
29. Uusitupa MI, Kumpulainen JT, Voutilainen E, Hersio K, Sarlund H, and Pyorala KP. Effects of Inorganic Chromium supplementation on Glucose tolerance, Insulin response, and Serum lipids in noninsulin-dependent diabetics. *American Journal of Clinical Nutrition, 1983;* 38: 404-10.

30. Anderson RA. Chromium and Polyphenol from Cinnamon improve Insulin Sensitivity. *Proc. Nutritional Society, 2008;* 67(1): 48-53.
31. Sherman L, Glennon JA, Brech WJ, Klomberg GH, and Gordon ES. Failure of Trivalent Chromium to Improve Hyperglycemia in Diabetes Mellitus. *Metabolism,* 1968; 17: 439-42.
32. Anisha P. Role of Chromium Compound in Diabetes. *Indian journal of pharmacy and pharmacology, 2016;* 3(1): 17-23.
33. Burtis CA, Ashwood ER, Bruns DE, and Sawyer BG. *Tietz Fundamental of clinical chemistry;* 6th edition, WB Sanders Co: Philadelphia, 2008; PA. 1124.
34. Salem M, Kholoussi S, Kholoussi N, and Fawzy R. Malondialdehyde and trace element levels in patients with type 2 diabetes mellitus. *Archieves Hell Medicine, 2011;* 28(1): 83-8.
35. Slater D, Botton CH, and Balle AJ. Theimportance of lipid derived malondialdehyde in diabetes mellitus. *Diabetologia*, 2000; 43: 550-7. www.myocilinic.org/diseases-conditions/diabetes/basics/complications/con-20033091 accessed on 14th May, 2016.