

# HISTOLOGICAL AND BIOCHEMICAL CHANGES IN SUCROSE-INDUCED METABOLIC SYNDROME ON KIDNEY OF WISTAR RATS

## ABSTRACT

**Introduction:** Metabolic syndrome is a cluster of metabolic abnormalities which confers upon an individual substantial increase in risk factors of cardiovascular disease including hypertension, central obesity, dyslipidemia and hyperglycemia.

**Aim:** The aim of the study was to determine the histopathological and biochemical parameters changes of kidney in sucrose induced metabolic syndrome on wistar rats.

**Methodology:** A total number of 24 wistar rats were randomly distributed into 3 groups. Group A was given normal distilled water which serve as control. Group B was given 10% sucrose distilled water and group C was given 20% sucrose distilled water. The blood specimens were collected and analysed for biochemical parameters (Sodium, Potassium, Chloride, Urea, and Creatinine, triglycerides, High density lipoprotein, Body mass index, Uric acid and Glucose).

**Results:** Results obtained revealed that sodium, potassium and chloride of group C (20% sucrose distilled water), the kidney parameters were significantly low when compared to with group B (10% sucrose distilled water) and control group. Serum Urea and Creatinine in group B (10%) and group C (20%) shows no statistical difference when compared with control group. The Triglycerides, High density lipoprotein and uric acid shows no statistical significant changes in both groups (10% and 20% sucrose distilled water) when compared with control group but glucose was significantly higher when compared with control group. The histological finding showed no changes on the histology of the kidney in group B (10% sucrose distilled water) but in group C (20% sucrose distilled water) there was scanty deposition of fats cells on the glomeruli.

**Conclusion:** The study shows that sodium, potassium and chloride were very low when compared with control but glucose was significantly higher when compared with control group. The histology of the kidney showed scanty deposition of fats cell in 20% sucrose distilled water.

**Key words:** Sucrose, Metabolic Syndrome and Kidneys

## 1.0 INTRODUCTION

Metabolic syndrome (MetS), also known as Syndrome X, Deadly quartet, Reaven's syndrome [2]. According to Srikanthan *et al.*, [17]. Metabolic Syndrome is a cluster of metabolic abnormalities which confers upon an individual a substantial increase in cardiovascular disease, and according to Lee *et al.*, [12]. they define it as a constellation of cardiovascular risk factors, including hypertension, central obesity, dyslipidemia, and hyperglycemia, it is a disorder of energy use and storage and finding suggest that approximately 20-25% of the world populations are suffering from MetS [16]. Individuals with metabolic syndrome are at higher risk to develop cardiovascular disease, stroke and disease related to fat deposition in artery walls [11]. Finding suggest that people with MetS has double the chance to develop heart disease or/and five times as likely to develop diabetes with people without the syndrome or/and three times as likely to have a heart attack or stroke [7]. While the pathogenesis of metabolic syndrome and its components is not well understood, central obesity and insulin resistance are recognized as causative factors [17]. Also nearly 40% of people over age 60 meet the criteria of having MetS [19]. The primary reason for developing MetS includes; overweight/ obesity, ethnicity, physical inactivity, genetic factors and aging [8]. It is estimated that around 20-25 percent of the world's adult population have the metabolic syndrome and they are twice as likely to die from and three times as likely to have a heart attack or stroke compared with people without the syndrome. In addition, people with metabolic syndrome have a fivefold greater risk of developing type 2

diabetes [10]. The prevalence of MetS increases with age, region, and population and varies widely depending on the definition used for treatment strategy (given International diabetes federation/World Health Organization) [21]. According to National Health and Nutrition Examination Survey (NHANES), prevalence of MetS in the US adults aged 18 years or older, rose by more than 35% from 1988-1994 to 2007-2012, increasing from 25.3% to 34.2% [4]. Approximately 7% of this population includes teens, of which nearly 7% were overweight and 29% were obese adolescents [7].

Sucrose is a natural sweetener most often called table sugar; there are three main sources of sucrose in the diet [14]. Sucrose is a common sugar, it is a **disaccharide**, a molecule composes of two monosaccharides; glucose and fructose. Sucrose is produced naturally in plants, from which table sugar is refined, it has a molecular **formula**  $C_{12}H_{22}O_{11}$ . Sucrose and **fructose** are not essential components of Man's feeding, and their consumption has remained low throughout the prehistory and middle age [20]. It has long been noticed that high-sugar intake may have adverse health effects [1, 3]. In rodents, consumption of a high-sucrose diet leads to the development of obesity, insulin resistance, diabetes, dyslipidemia, fatty liver, and high blood pressure [1]. More than 50 years ago, it had already been suspected that consumption of refined sugar in humans may be linked to dyslipidemia and coronary heart disease [15].

### **3.0 MATERIALS AND METHOD**

#### **3.1 STUDY LOCATION**

The study was conducted at the department of Histopathology, School of Medical Laboratory Sciences, Usmanu Danfodiyo University Sokoto and Histopathology Laboratory, Usmanu Danfodiyo University Teaching Hospital.

#### **3.2 EXPERIMENTAL ANIMALS**

Twenty four (24) adult wistar rats with an average weight of 120-150kg was purchased from the Department of Pharmacology and Toxicology, Faculty of pharmaceutical science, Ahmadu Bello University Zaria and was transported to Sokoto, there were kept in animals house, Faculty of Pharmaceutical Science, Usmanu Danfodiyo University Sokoto. The rats were housed in a metal cage with 12 hours dark/light cycle. They were fed with standard pellets (grower mesh) and pure water with different concentration of sucrose solution (10% and 20%). The animals were allowed to acclimatize for 2 weeks before proceeding to the study. Before the commencement of the study, physical examination of the animals were carried out and were found to be in a very good state of health and were kept before the day of sacrifice.

#### **3.3 PROCUREMENT OF SUCROSE**

Sucrose was obtained from Gawon Nama Market along Usmanu Danfodiyo University Teaching Hospital, Wamako Local Government Sokoto State.

##### **3.3.1 PREPARATION OF SUCROSE SOLUTION**

- 10% preparation, 10g of sucrose was weighed and diluted in 100ml of distilled water.
- 20% preparation, 20g of sucrose was weighed and diluted in 100ml of distilled water.

#### **3.4 EXPERIMENTAL DESIGN**

A total number of 24 adult wistar rats were randomly divided into 3 groups as A, B, and C. Each group consist of Eight rats, group A serve as control in which pure water was used as their drinking water, group B 10% of sucrose solution was used as their drinking water and finally group C 20% of sucrose solution was used as their drinking water, Where by the sucrose solution was prepared daily for the entire groups for the period of 42 days (6 weeks).

#### **3.5 ANIMALS SACRIFICE AND SAMPLE COLLECTION**

The animals were weighed and sacrificed following mild anesthesia with chloroform inhalation in an enclosed transparent plastic jar. The blood samples for biochemical studies were collected in plain containers via cardiac puncture; the kidney was carefully harvested and washed with normal saline then fixed in 10% formalsaline.

#### **3.6 LABORATORY ANALYSIS**

Urea Estimation was done using DAM method (Diacetyl monoxime method). Creatinine estimation using (alkaline picrate method by Jaffe's), and Grant *et al*, [6] sodium and potassium estimation using (flame photometric method)

#### **3.7 HISTOPATHOLOGICAL ANALYSIS**

## MICROSCOPY AND PHOTOMICROGRAPH:

The photomicrographs of tissue section were taken using light microscope and BestScope camera and the results were presented alongside with control.

### 3.9 DATA ANALYSIS

The results generated were analyzed using Graph pad inStat software. Normally testing was done and the data spread were found to be normally distributed. One-way analysis of variance was adopted as a parametric tool for mean comparison between the study groups. P value less than 0.05 was considered statistically significant.

### 4.0 RESULT.

The changes of the kidney biochemical parameter in sucrose induced distilled water as agent of metabolic syndrome was determined which include Urea Sodium, Potassium, chloride and Creatinine, the results are presented in table 1. The mean differences in Urea concentration between 20% sucrose distilled water (Group C) and 10% sucrose distilled water (Group B) shows no statistical significant ( $P > 0.05$ ) but it is significant ( $P < 0.05$ ) when compared with the control. The result further shows no significant change ( $P > 0.05$ ) in creatinine concentration both in test and control. The mean differences in 20% (sodium, Potassium and Chloride)

concentration is significantly ( $P < 0.05$ ) lower than that of 10% and control.

Results of Body mass index (BMI), serum Triglycerides, High density lipoprotein- cholesterol (HDL-CHOL), Uric acid and Glucose, are presented in table 2. The mean differences in 20% sucrose distilled water (Group C) concentration of (Uric acid, TG, HDL, BMI) were found to be no statistical significant ( $P > 0.05$ ) when compared with 10% sucrose distilled water (Group B) and control. However the differences in 20% sucrose distilled water (Group C) glucose concentration is significantly ( $P < 0.05$ ) higher than that of 10%, sucrose distilled water (Group B) but not significant ( $P > 0.05$ ) when compared with the control

The stained slides were examined to determine the changes of sucrose distilled water on the histology of the kidney. The kidney section shows normal general structure of the kidney in group B (10% sucrose distilled water) when compared with control (plate 1), the glomerulus was well preserved with bowman' normal space. While group C (20% sucrose distilled water), the histology of the kidney shows normal general structure of kidney with scanty deposition of fats when compared to control (plate 2), the glomeruli were well preserved with abundant bowman's space.

**Table 1: Electrolytes, Urea and Creatinine (Renal Function Test)**

Parameter	Control (Group A)	10% SDW (Group B)	20% SDW (Group C)
Urea (mmol/L)	5.50± 1.59 <sup>a</sup>	8.75± 1.89 <sup>b</sup>	7.95± 1.44 <sup>b</sup>
Creatinine (mg/dL)	0.78± 0.3 <sup>a</sup>	1.05± 0.31 <sup>a</sup>	0.73± 0.23 <sup>a</sup>

<b>Sodium (mmol/L)</b>	146.50± 4.28 <sup>ab</sup>	158.75± 16.26 <sup>b</sup>	141.67± 4.66 <sup>a</sup>
<b>Potassium (mmol/L)</b>	5.24± 0.35 <sup>a</sup>	6.60± 1.00 <sup>b</sup>	5.56± 0.96 <sup>ab</sup>
<b>Chloride (mmol/L)</b>	90.00± 4.04 <sup>a</sup>	101.50± 9.12 <sup>b</sup>	88.25± 3.45 <sup>a</sup>

Values are expressed as mean ± SD. Values with the same superscript in same row are statistically insignificant (P >0.05) and those with different superscript in the same row are statistically significant.

**KEYS :** 20% SDW (20percent sucrose distilled water), 10% SDW (10percent sucrose distilled water), Mmol/L= **Millimole** per liter, Mg/dL= Milligram per deciliter

**Table 2: Uric acid, Body mass index, Glucose, Triglycerides High density lipoprotein cholesterol parameters**

<b>Parameter</b>	<b>Control (Group A)</b>	<b>10% SDW (Group B)</b>	<b>20% SDW (Group C)</b>
<b>Uric acid (mg/dl)</b>	2.59± 1.39 <sup>a</sup>	4.36± 1.49 <sup>b</sup>	4.05± 1.55 <sup>c</sup>
<b>TG (mg/dl)</b>	104.13± 18.45 <sup>a</sup>	125.00± 50.79 <sup>b</sup>	147.13± 85.89 <sup>c</sup>
<b>HDL-Chol (mg/dl)</b>	54.50± 26.96 <sup>a</sup>	55.25± 20.28 <sup>b</sup>	56.25± 37.16 <sup>c</sup>
<b>BMI (g/cm)</b>	0.75± 0.09 <sup>a</sup>	0.77± 0.23 <sup>b</sup>	0.80± 0.16 <sup>c</sup>
<b>Glucose (mmol/L)</b>	4.55± 0.85 <sup>a</sup>	6.96± 1.42 <sup>b</sup>	8.49± 2.35 <sup>b</sup>

Values are expressed as mean ± SD. Values with the different superscript in same row are statistically insignificant (P >0.05) and those with same superscript in the same row are statistically significant.

**KEYS:** 20% SDW (20percent sucrose distilled water), 10% SDW (10percent sucrose distilled water), TG= Triglycerides, BMI= (Body mass index). Mg/dL= Milligram per deciliter, g/cm= Grams per centimeter and Mmol/L= Millimole per Liter

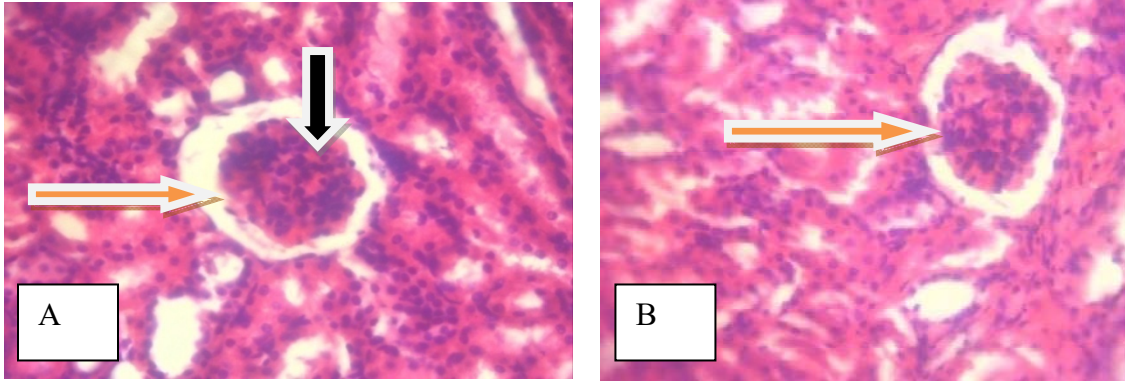


Plate 1: Kidney section A = Control and B= Group B (10% sucrose distilled water) stained with Haematoxylin and Eosin  $\times 400$ .

**LEGEND:** Section of kidney tissue showing normal general histological structures, Black arrows showing normal capsular space and Brown arrow showing normal Glomerular capillaries in both control and test.

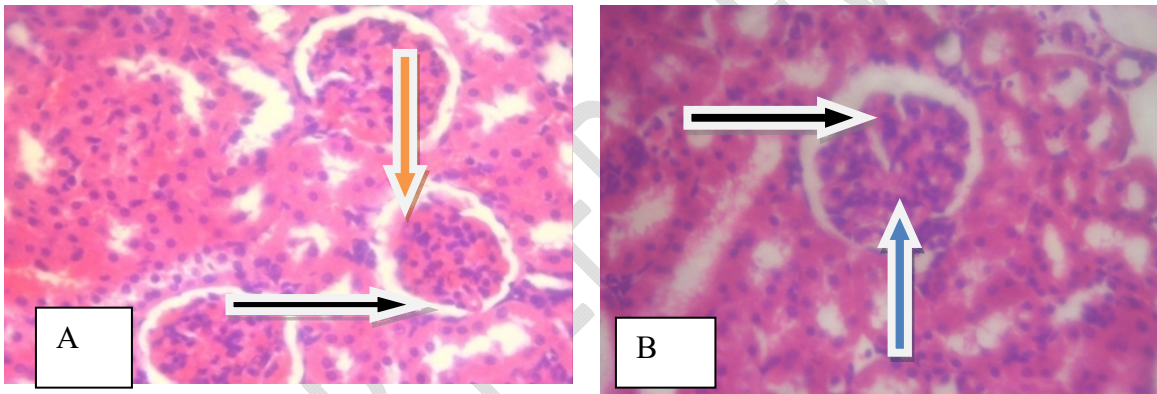


Plate 2: Kidney section A=Control and B= Group C (20% sucrose distilled water) stained with Haematoxylin and Eosin  $\times 400$ .

**LEGEND:** Section of kidney tissue showing normal general histological structures, Black arrows showing normal capsular space in control, while in test brown arrow showing capsular space and blue arrow showing normal glomerular capillaries with scanty deposition of fats.

## 5.0 DISCUSSION

The study conducted using Group A as control which was administered with distilled water, Group B administered with 10% sucrose distilled water and group C which was administered with 20% sucrose distilled water which was used as an agent of metabolic syndrome. The results shows that the biochemical

parameter of Sodium, Potassium and Chloride in 10% sucrose distilled water were not statistically significant ( $P > 0.05$ ) when compared with control, this findings were not in agreement with the findings reported by [13], this could be due to the differences in animals model used and methods of estimation of the analytes, but in 20% sucrose distilled water they were statistically

significant ( $P < 0.05$ ) when compared with control group this was in line with the findings reported by Marek kretowicz *et al.*, [13; 6]. This could be attributed to the fact that the same method of estimation of the analytes was used. However, Urea show no statistical significant ( $P > 0.05$ ) difference within the test groups that is 10% Sucrose distilled water and 20% Sucrose distilled water, but there was statistical difference when compared with control group and this was in agreement with the finding reported by Marek kretowicz *et al.*, [13; 9; 6]. The Creatinine shows no statistical difference in 10% sucrose distilled water and in 20% sucrose distilled water when compared with control group.

The Triglycerides, body mass index, high density lipoprotein cholesterol and Uric acid were found to be no statistical significant ( $P > 0.05$ ) difference within the groups that is 10% Sucrose distilled water and 20% Sucrose distilled water when compared with control. This was not in agreement with the previous findings reported by Darvallet *et al.*, [13]. This might be due to higher dosage of sucrose distilled water solution during induction of metabolic syndrome and also the duration for the induction was longer in their research work which was up to 12 weeks. But the Glucose level in 20% sucrose distilled water was statistical significant increase than that of 10% sucrose distilled water when compared with control which was in line with findings reported by Darvall *et al.*, [13].

The histological findings show normal general structure and normal architecture of the kidney with well-preserved capsule, bowman, glomerulus and renal tubules in 10% sucrose distilled water

and control group, this results was in line with the previous findings reported by Sanchez-Tores *et al.* [16]. which shows that no morphological changes found between control group and test groups. While for the 20% sucrose distilled water the general structure of the kidney shows normal kidney architecture but with scanty deposition of fats cells around the glomeruli this findings were in line with the previous report carried out by Sanchez-Tores *et al.* [16], that was reported to both the control groups and the test groups shows normal general structure and normal architectures of the kidney but with presence of fat cells infiltration into the glomeruli seen in 20% sucrose distilled water section.

## 5.1 CONCLUSION

The findings from the study shows that sodium, potassium and chloride of the kidney parameters were very low when compared with control group and glucose was significantly higher when compared with control group. There were no histological changes on the histology of the kidney but there was scanty deposition of fats cell in the glomeruli of 20% sucrose distilled water.

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