# The Role of Oral Administration of Sucrose Concentration on the Biochemical Parameters of Ovaries

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***ABSTRACT***

***Background:*** *The amount of sucrose present in the diets consumed globally today is at very high levels and there are growing concerns on the effect of sucrose as underlying pointers to major terminal ailments*

***Objective:*** *The overall objective of this study is to determine the effect of sucrose on the antioxidants of the ovaries using Sprague-Dawley (S-D) rats as an experimental model.*

***Methods:*** *A total of fifteen (15) adult female Sprague-Dawley rats weighing between 150± 20 g were used for this study. Group A served as control and received 1 ml of distilled water (DW). Group B and C served as low dose and high dose and received 0.71 and 8.13 mg/kg respectively for duration of 4 weeks. Upon completion of the administration, the rats were euthanized and their ovaries were harvested for histology, oxidative stress markers and blood from ocular sinus for hormonal tests.*

***Results:*** *Observation over the experiment duration showed an increase in body weight in both low dose (29.25%) and high dose (15.78%) treatment groups. Also, an increase of 2.23% was also recorded in the control group. The cytoarchitectural analysis showed ovarian stroma and moderate vascular congestion within the ovaries. The hormones showed a dose-dependent steady decrease in the levels of Luteinizing hormone and Follicle Stimulating hormones. Also, there was an increase in the values of Malondialdehyde.*

***Conclusion:*** *This study shows that sucrose has an adverse effect on the hormonal milieu, cytoarchitecture of the ovaries which can affect the female reproductive system culminating into infertility.*

**Keywords:** Malondialdehyde, Luteinizing Hormone, Follicle Stimulating Hormone, Ovaries

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## INTRODUCTION

One of the most common and widely consumed food substances in the world today is sucrose, as it can be eaten as a pure substance and it is also added to diets to make them palatable (1).

Life's primary energy source is carbohydrates, and sucrose is an essential nutrient for human nutrition. In fact, one of the most crucial ingredients in the food business is sucrose. The relevant role of inverted sugar—a combination of glucose and fructose—that results from breaking the sucrose's glycosidic bond must be noted in this context. A very nutritious ingredient in a wide variety of foods is sucrose. However, consumption of it is a public health concern linked to obesity, diabetes, and other long- term health issues, which has spurred research on this extremely important carbohydrate(2). A study carried out in 2019 showed that the world's population has consumed 177.8 million metric tons of sucrose (3). This could have a harmful effect on the general well-being of the body. Some of the harmful impacts that sucrose has on the health includes; increases the risk of type 2 diabetes, it is associated with weight gain which can make heart diseases to arise, stroke, cancers

and imbalance of the hormonal system of the body(4). The increasing ratio of individuals suffering from chronic diseases as diabetes and obesity increased the importance of sugar substitutes as an alternative to sucrose.

Sugar substitutes are food additives that duplicate the sweeten taste of sucrose with less or no calorie(5). Several researches conducted in recent years has shown that the constant high sugar intake could possibly negatively impact fertility in females(6). Another study also showed anomalies in the histology of the ovary and uterus indicating that sugar disrupted the estrous cycle and altering the weights and cytoarchitecture of the ovary and uterus(7). Hence the birth of this research on the effect of sucrose consumption on the antioxidant enzymes in the ovaries, using Sprague-Dawley rats as experimental models. A study conducted showed that the consumption of soft drinks per day reduced conception rates in females by a quarter(8).

This is because sugar can interfere with reproductive hormones and imbalance (9). As much as sugar is eaten, the blood sugar level would increase which would cause the body to produce an increased amount of insulin (10). This is a mechanism the body uses to move this sugar out of the bloodstream and into the cells for energy production. but high blood sugar and high insulin levels have the potential to significantly impact on the reproductive health.

## MATERIALS AND METHODS

### Source of sucrose

The sucrose was purchased from Guangdong Guanghua Sci-Tech Co., Ltd, with a product license number: XX13-011-000005, manufactured on 04/01/21 and an expiration date on 04/01/2026.

### Animals

A total of fifteen (15) adult female Sprague-Dawley rats weighing between 150 ± 20 g were used for this study. The animals were procured from the animal house of the department of human anatomy, Bowen University, Iwo, Osun State, Nigeria. They were acclimatized for a period of two weeks. They were placed in well-ventilated plastic cages and fed with standard rat chow and water. They were kept under hygienic conditions within a normal environmental temperature and relative humidity. Wood shavings were used as beddings for the animals in the plastic cage, and this was changed daily to ensure proper sanitation. The animals were grouped into three (A-C). Group A served as control and received 1 ml of distilled water (DW). Group B-C served as low dose and high doses and received 0.71 and 8.13 mg/kg respectively for duration of 4 weeks. Upon completion of the administration, the rats were euthanized and their ovaries were harvested for histology, oxidative stress markers and blood from ocular sinus for hormonal tests.

### Antioxidant enzymes assay

The ovaries harvested for this assay were placed in organ bottles and then kept in the freezer at -80ºC for preservation, following the procedure as described by our previous study (11).

### Blood sampling and hormonal assay

Blood was collected from ocular sinuses of the eye using capillary tubes and left to clot for separating the serum after centrifugation at 3000 rpm for 10 minutes. The sera were kept in a freezer at -80 C for hormonal assay was performed. Luteinizing (LH), and Follicle-Stimulating Hormones (FSH) were measured as described by our previous study (11).

### Histological process

The ovaries that were used for the histological process were collected in organ bottles and fixed using Bouin's fluid. The tissues were processed for microscopic examination using standard procedure for preparation of Hematoxylin and Eosin stain.

### Data analysis

The data obtained was computed, analyzed and summarized using Graph Pad Prism software version 8.0. Results were expressed as Mean ± Standard error of mean (SEM). The analysis was done using ONE- WAY ANOVA analysis, followed by Newman- Keuls post hoc statistical tests. Comparison between the control and the treatment groups were made and values of $P<0.05$ were considered significant

## RESULTS

### The effect of sucrose concentration on the body weight of Sprague-Dawley rats

A comparison was carried out before and after administration of sucrose concentration and an increase in body weight was observed in both low dose (29.25%) and high dose (15.78%) treatment groups. Also, an increase of 2.23% was also recorded in the control (Table 1).

The effect of sucrose concentration on the follicle stimulating hormone (FSH) of Sprague- Dawley rats

When the treatment groups were compared to control, significant dose-dependent decrease in value was recorded ($P<0.05$). When high dose was compared to low dose, significant decrease was noticed ($P<0.05$) as seen in Figure 1.

**Table 1: The effect of sucrose concentration on the body weight of Sprague-Dawley rats**

| Sucrose | | | |
|---|---|---|---|
| Groups | Before Administration | After Administration | % Difference in body weight |
| Control | 156.6 ± 7.69 | 160.1 ± 4.55* | 2.23 |
| Low dose | 122.7 ± 3.55 | 158.6 ± 5.75* | 29.25 |
| High dose | 146.3 ± 2.25 | 169.4 ± 1.59* | 15.78 |

Values are mean standard error of mean; n=5, *p<0.05(Student's T test)

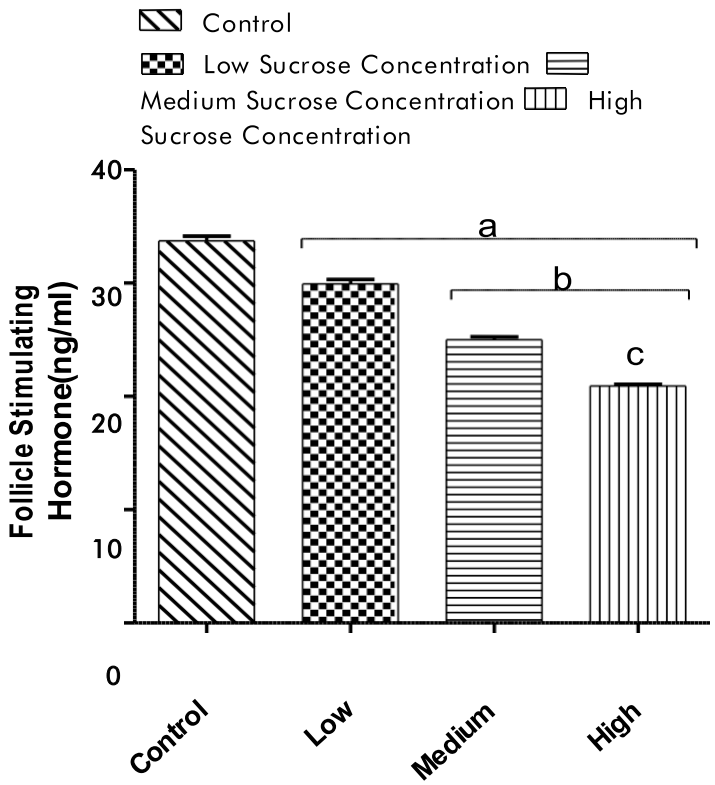


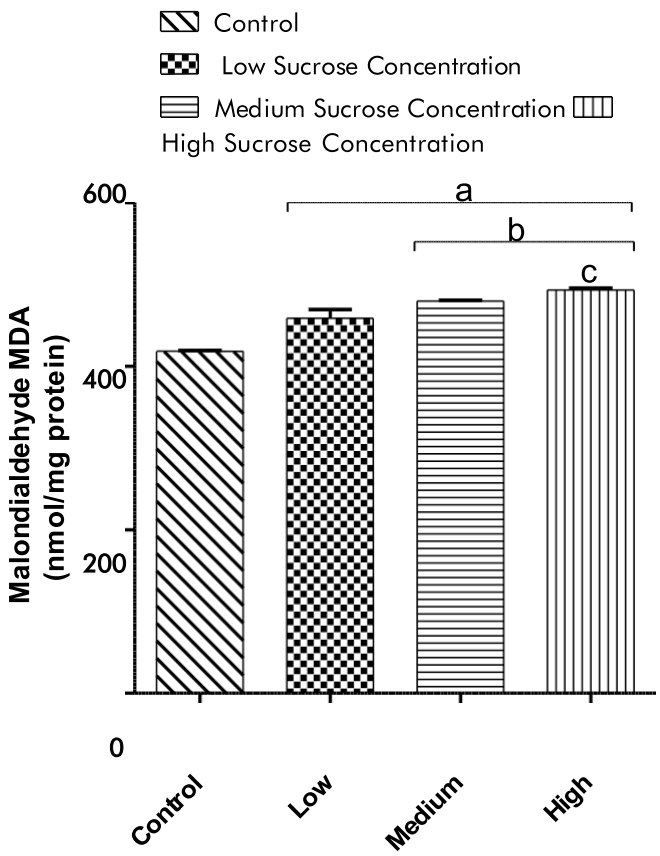

**Figure 1: The effect of sucrose concentration on the Follicle Stimulating Hormone (FSH) of sprague- dawley rats**
Values are expressed as mean ± Standard Error of Mean (SEM). $^{a}p<0.05$ significant compared to control; $^{b}p<0.05$ significant compared with low dose; $^{c}p<0.05$ significant compared with medium dose.

### The effect of sucrose concentration on the Luteinizing hormone (LH) of sprague-dawley rats

When the treatment groups were compared to control, significant dose-dependent decrease (P<0.05) in value of luteinizing hormone was recorded. When high dose was compared to low dose, significant decrease was recorded (P<0.05) as seen in Figure 2

### The effect of sucrose concentration on the Malondialdehyde (MDA) of sprague-dawley rats

When the treatment groups were compared to control, significant dose-dependent increase in value (P<0.05) of MDA was recorded. When high




Values are expressed as mean ± Standard Error of Mean (SEM). [a]p<0.05 significant compared to control; [b]p<0.05 significant compared with low dose; [c]p<0.05 significant compared with medium dose.

**Figure 3: The effect of sucrose concentration on the Malondialdehyde (MDA) of Sprague-Dawley rats**

Values are expressed as mean ± Standard Error of Mean (SEM). [a]p<0.05 significant compared to control; [b]p<0.05 significant compared with low dose; [c]p<0.05 significant compared with medium dose.

dose was compared to low dose, significant increase was recorded (P<0.05) as seen in Figure 3

### The effect of sucrose concentration on the Superoxide dimutase (SOD) of sprague-dawley rats

When the treatment groups were compared to control, significant decrease was seen in low dose and increase seen in medium and high doses in values of SOD was recorded (P<0.05). When high dose was compared to low dose, significant increase was noticed (P<0.05) as seen in Figure 4

### The effect of sucrose concentration on the catalsase (CAT) of sprague- dawley rats

When the treatment groups were compared to control, significant dose-dependent decrease in value (P<0.05) was recorded. When high dose was compared to low dose, significant decrease was recorded (P<0.05) as seen in Figure 5

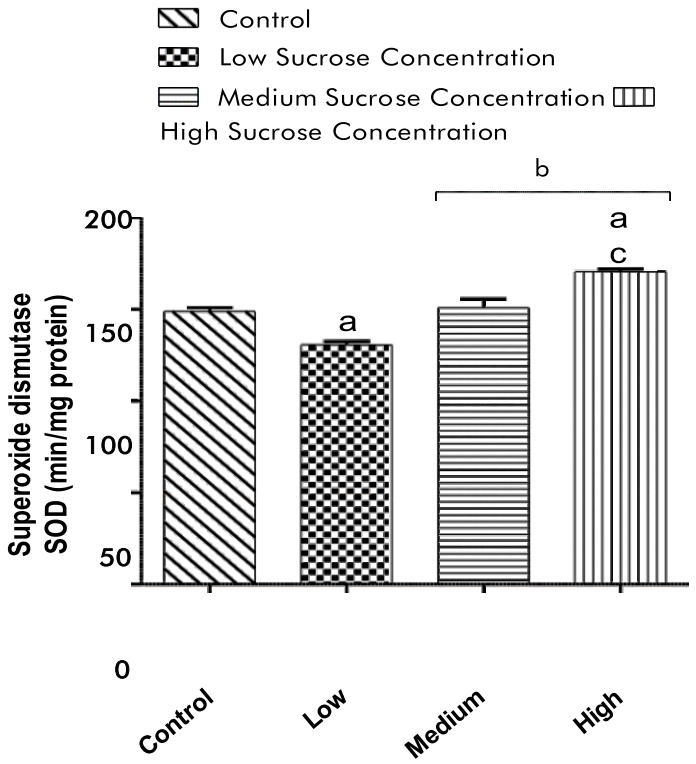



**Figure 4: The effect of sucrose concentration on the Superoxide dismutase (SOD) of sprague-dawley rats**

Values are expressed as mean ± Standard Error of Mean (SEM). [a]p<0.05 significant compared to control; [b]p<0.05 significant compared with low dose; [c]p<0.05 significant compared with medium dose.

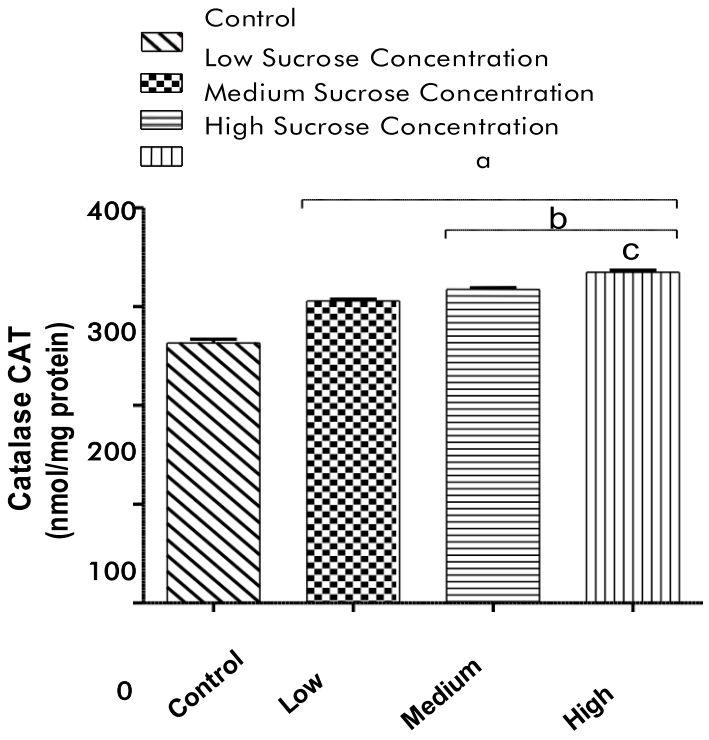



**Figure 5: Effect of sucrose concentration on the Catalase (CAT) of sprague-dawley rats**

Values are expressed as mean ± Standard Error of Mean (SEM). [a]p<0.05 significant compared to control; [b]p<0.05 significant compared with low dose; [c]p<0.05 significant compared with medium dose.

## DISCUSSION

Generally, we consume food every day in order for our bodies to have energy to go through the day. The most popular ingredients in most of the diets present today is carbohydrate as it is also recommended by dietitians to be included in the diet (12). At the end of the day, the carbohydrate would end up as glucose which would energize the body (13). Apart from carbohydrate, additional sucrose (sugar) is also added to the diets for several purposes which can be either to sweeten the food or to preserve the food(14). In our body, the roles that antioxidants play is a very important role as it prevents oxidative stress which when occurs causes severe damage to that part of the cells of the body (15). Specifically, oxidative stress in the ovaries would affect the physiological processes from oocyte maturation to fertilization and embryo development (16).

According to this research, it is seen that the antioxidant enzymes which are also known as oxidative stress biomarkers are all increasing steadily as it is seen that there is significant difference between the control group and the treatment groups. The levels of Malondialdehyde in the treatment groups are increased and this could pose danger to an individual's health. This according to (17) suggests the indication of metabolic syndrome. Also, according to (18), it is said to increase the possibility of oxidative stress, particularly lipid peroxidation which would contribute to contribute to sepsis pathophysiology. The levels of Catalase, Superoxide dismutase and Glutathione in the treatment groups are steadily increasing in value and (19) suggests that an increased catalase level in the ovaries would contribute to follicular development and steroidogenic events in the ovaries and increased superoxide dismutase level would serve as a luteinizing hormone releasing factor and an increased glutathione level would protect the ovaries from apoptosis in large antral follicles.

The levels of the reproductive hormones recorded at the end of this study steadily reduced in their levels. As seen in the study Luteinizing hormone and Follicle Stimulating Hormone had low levels and this is said to cause incomplete development at puberty and ovarian failure which cause improper growth of the ovarian follicle and the inability to release eggs. Also, both luteinizing hormone (LH) and follicle-stimulating hormone (FSH) are required for follicle development and the low levels of these hormones may mean that fewer numbers of follicles will develop and there could possibly be no Graafian follicle formation (20). This can also be seen in studies where there were decrease in these reproductive hormones and these deficiencies were associated with reduced gametogenesis and steroidogenesis (21-23) Estrogen and progesterone are secreted in response to luteinizing hormone (LH) and follicle stimulating hormone (FSH), and these hormones controlsexual development, arousal, and conception (24). Infertility can eventually result from anything that reduces or blocks the production of LH or FSH, such as gonadotropin deficiency, hypopituitarism, hyperprolactinemia, and gonadal suppression therapies (25). Gonadotrophins, such as FSH and LH, are produced in the anterior pituitary gland in response to stimulation from hypothalamic cells. These hormones have reproductive importance for the ovary because they are essential for promoting cohort follicular growth each cycle until ovulation and maturation (26).

According to studies, FSH and LH are anti- apoptotic hormones, which means that a drop in these hormone levels in the serum may cause early atresia or follicle/oocyte degeneration (27– 29). Reduced oocyte quality, fertilization, pregnancy, and the live birth rate have all been linked to early apoptosis or oocyte degeneration brought on by a drop in FSH and LH (29). One possible outcome of these disturbances could be the release of aberrant or apoptotic oocytes during ovulation, which would prevent implantation. According to Tiwari et al. (28) neem leaf extract's bioactive agents caused oocyte apoptosis, which in turn had a negative impact on reproductive outcomes.

## CONCLUSION

According to the hormonal tests the concentrations of sucrose used caused a reduction in the vital hormonal levels which is said to be detrimental to the female reproductive health. While biochemical analysis achieved for the concentrations of sucrose caused an increase in the levels of the biomarkers and it can be assumed that oxidative stress has not occurred. The histology of the ovaries for all the groups had no change so it can be said that the concentration of sucrose used for this study did not

affect adverse effect of the cyto- architecture on the ovaries, hence, we recommend caution in the consumption of sugar among females as it could possibly affect their reproductive health.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## CONFLICTS OF INTEREST AND OTHER DISCLOSURES

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All authors names and designated addresses are confirmed.

All authors approve of this submission

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