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Original

Cellgevity®: Preventive Potential Against High Fructose Diet-Induced Inflammation And Oxidative Stress

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Abstract

Background: Modern diets high in fructose, have been linked to metabolic disorders, inflammation and oxidative stress. Herbal supplements like Cellgevity®, touted for their anti-inflammatory and antioxidant properties, therefore needed to be investigated.

Objectives: This study was aimed to evaluate the potential of Cellgevity®, a herbal supplement, in preventing inflammation and oxidative stress, induced by a high fructose diet.

Methods: Twenty male rats, (about 200g each), were divided into four groups of five rats each: the control, high fructose diet with fructose water (HFD+FW), HFD+FW with Atorvastatin (0.57 mg/kg-b.w), and HFD+FW with Cellgevity® (26.15 mg/kg-b.w), groups. After a 28-day experimental period, they were sacrificed and blood samples collected and analyzed for the levels of high sensitive C-reactive protein (HsCRP), malondialdehyde (MDA), and total antioxidant capacity (TAC). Statistical analysis, was done using the SPSS-20 package.

Results: Rats on high fructose diet had significantly ($P<0.05$) elevated HsCRP levels (0.63±0.04 mg/dl) compared to those of the control (0.27±0.01 mg/dl). When compared with the HFD+FW group (0.63±0.04 mg/dl), Atorvastatin and Cellgevity® prevented significantly ($P<0.05$), the rise in HsCRP levels (0.28±0.00 mg/dl; 0.29±0.01 mg/dl respectively), while only Cellgevity® significantly ($P<0.05$) prevented an increase in the MDA levels (HFD+FW: 0.32±0.01 μM; Cellgevity®: 0.09±0.02 μM). Atorvastatin and Cellgevity® both significantly ($P<0.05$) prevented a fall in the TAC levels (0.38±0.03 μmol/ml; 0.59±0.03 μmol/ml respectively) compared to the HFD+FW group (0.21±0.06 μmol/ml), with Cellgevity® being more effective.

Conclusion: Cellgevity® therefore showed promise as a supplement that can prevent high fructose diet induced inflammation and oxidative stress.

Keywords: High fructose diet, Cellgevity®, inflammation, oxidative stress.

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Introduction

The pervasive availability of processed foods and sugar-sweetened beverages making use of high fructose syrup, has fueled a significant rise in the consumption of high-fructose diets worldwide. This dietary trend has been paralleled by a surge in the prevalence of cardiovascular and metabolic disorders, especially type 2 diabetes mellitus and cardiovascular diseases preceded by a syndrome known as metabolic syndrome, the core component of which includes central obesity, insulin resistance, dyslipidaemia and hypertension (1, 2). Metabolic syndrome is the term used to describe the pre-diseased state that often precedes more severe cardiovascular and metabolic disorders. Due to the surge in high fructose diets, coupled with urbanization and sedentary lifestyle, the prevalence of metabolic syndrome is rising worldwide. The overall prevalence of metabolic syndrome in Nigeria is about 35.1% (3), this is high and there is the possibility of it going higher due to the adoption of western-style diet and increased sedentary living in Nigeria (3). In our environment, following the excessive consumption of fructose, a dyslipidaemia ensues, which activates a chronic low-grade inflammation and oxidative stress. Central to the pathogenesis and development of metabolic syndrome, is an increase in insulin resistance occasioned by the oxidative stress and inflammation which are the end effects of the metabolism of excess fructose (4, 5).

Fructose metabolism diverges markedly from that of glucose, with unique implications for metabolic health. Unlike glucose, which is primarily metabolized in the liver, fructose metabolism occurs predominantly in the small intestine, leading to distinct metabolic outcomes that end up being transported to the liver via the portal vein (6). Excessive fructose intake can overwhelm hepatic metabolic pathways, resulting in the accumulation of metabolic intermediates and the deregulation of lipid metabolism, hence the dyslipidaemia and increase in free fatty acids associated with a high fructose diet (7). It has been shown too that, fructose metabolism eventually leads to the generation of reactive oxygen species (ROS) and promotes the production of pro-inflammatory cytokines, contributing to oxidative stress and inflammation (8, 9).

"A high fructose dietary pattern has emerged as a significant contributor to the hyperglycaemia and dyslipidaemia that cause persistent low-grade inflammation and oxidative stress. This adversely affects the liver and β-cells of the pancreas, and the subsequent development of insulin resistance, and metabolic syndrome, which is a precursor to type 2 diabetes" (10). Systemic low-grade inflammation can be defined as a 2- to 3-fold increase in plasma levels of cytokines and acute phase proteins, like C-reactive protein (CRP) (11, 12). C-reactive protein (CRP), are acute phase proteins, involved in innate immune responses, activation of the complement system and enhancing phagocytosis (12). It is involved in aggravating the inflammation that gives rise to the metabolic and physiological changes that is characteristic of metabolic syndrome. They are known to induce endothelial cells to express intracellular adhesion molecule-1 (ICAM-1) and vascular cell adhesion molecule (VCAM) and stimulate monocytes to release proinflammatory cytokines such as interleukin-6 (IL-6), interleukin-1 beta (IL-1), and tumour necrosis factor alpha (TNF-)-,which are all factors that will promote further inflammation and oxidative stress (12). CRP has been recognized as the inflammatory marker with the strongest association with pre-diseased states leading to cardiovascular and metabolic diseases, such as metabolic syndrome, pre-hypertension and even hypertension (12). It has also been discovered that pre-hypertensive patients generally have a higher plasma CRP level when compared with that of their normotensive patients and higher baseline CRP levels are reportedly associated with a higher risk of developing overt hypertension and diabetes mellitus (12). This is consistent with the concept that systemic low-grade inflammation, which eventually cause metabolic syndrome, precedes increased insulin resistance, hypertension and diabetes mellitus. Though CRP is the general name of the protein in question, in the laboratory what is sometimes measured for sensitivity and specificity to inflammation and cardiovascular and metabolic diseases, is high sensitive CRP (HsCRP). Numerous epidemiological studies have shown that plasma HsCRP level is a powerful predictor of both impending and actual cardiovascular and metabolic disease events in patients that are at risk and may even predict cardiovascular and metabolic events among apparently healthy subjects (12, 13).

Studies have shown that HsCRP and products of lipid peroxidation are also elevated in hyperlipidaemia, as hyperlipidaemia is known to stimulate inflammatory and oxidative processes that involves an increase in the blood levels of CRP and products of lipid peroxidation. Also, simvastatin or atorvastatin meant for reduction of high cholesterol level, have been shown to induce a reduction of CRP and Malondialdehyde (MDA) in hyperlipidaemic conditions (12, 13). This is obviously because as it prevents dyslipidaemia, it removes the factor (hyperlipidaemia) that stimulates the inflammation and rise in CRP and MDA in the first place.

In light of these detrimental effects, there is growing interest in identifying strategies to counteract the adverse consequences of high-fructose diets. One such approach involves the use of nutritional supplements aimed at bolstering antioxidant defenses and mitigating oxidative stress. Among these supplements, Cellgevity® has emerged as a promising candidate due to its unique formulation and purported ability to support glutathione synthesis. Cellgevity® contains RiboCeine™, a patented compound designed to enhance glutathione production by providing cysteine, the rate-limiting precursor for glutathione synthesis (14, 15). Additionally, Cellgevity® contains a blend of other bioactive ingredients, including selenium, alpha-lipoic acid, turmeric extract, resveratrol, quercetin, grape seed extract, and vitamin C, all of which have been implicated in anti-hyperlipidaemic effects, as well as anti-inflammatory and antioxidant defense and cellular protection (15-17). By replenishing intracellular glutathione levels and providing a comprehensive array of antioxidant compounds, Cellgevity® aims to restore antioxidant balance and mitigate the deleterious effects of oxidative stress.

While several studies have investigated the potential benefits of Cellgevity® in various experimental models, the specific impact of Cellgevity® on high-fructose diet-induced inflammation and antioxidant imbalance, have not been investigated. This present study therefore sought to address this gap in knowledge, by comprehensively evaluating the protective and preventive effects of Cellgevity® in a rat model of high-fructose diet-induced inflammation and oxidative stress. By providing insight into the potential role of Cellgevity® in mitigating fructose-induced inflammation and oxidative stress, this study aims to contribute to the development of novel strategies for the prevention of diseases that can result from inflammation and oxidative stress due to a high-fructose diet.

Methodology

Chemicals, Drugs, and Kits:

Cellgevity®, a herbal supplement produced by Max International, U.S.A and was purchased from an accredited distributor in Benin City, Edo State, Nigeria. Atorvastatin, an orthodox anti-lipidaemic drug with ancillary anti-inflammatory and antioxidant properties, was procured from pharmaceutical outlets situated opposite the University of Benin Teaching Hospital (UBTH) along Ugbowo Lagos Road, Benin City, Edo State, Nigeria. The High Sensitive C-reactive protein (HsCRP) ELISA kit by MyBioSource, USA, was procured from the manufacturer's representative in Nigeria and included a Microtiter plate (96 well plate) and reagent vials and eight vials of standards (S1: 0ng/ml, S2: 0.156ng/ml, S3: 0.312ng/ml, S4: 0.625ng/ml, S5: 1.25ng/ml, S6: 2.5ng/ml, S7: 5.0ng/ml, S8: 10ng/ml). The reagents and materials used for the assessment of malondialdehyde included 1% Thiobarbituric acid (TBA), 0.4% NaOH, glacial acetic acid, and distilled water, all obtained from an authorized vendor - Pyrex Laboratories in Benin, Nigeria, and were of analytical grade. For the evaluation of Total Antioxidant Capacity, materials sourced from the manufacturer's representative of MyBioSource Incorporated USA, in Benin City, Nigeria was the Rat total antioxidant capacity (TAC) microplate assay kit which included the microplate, the assay buffer (30 ml x 4 vials), reaction buffer (16 ml x 1 vial), substrate powder (x 1 vial), dye reagent powder, dye reagent diluent (2 ml x 1 vial), and standard powder (x 1 vial).

Experimental Animals:

The male Wistar rats (n=20) utilized in this study were acquired from the Anatomy Department, School of Basic Medical Sciences, University of Benin, Benin City, Nigeria. They were about 7 weeks old and weighed between 180g to 220g. Following international guidelines (18), a two-week acclimatization period was observed for these rats before commencing the experiments. Additionally, ethical clearance and approval, with approval Number: CMS/REC/2023/485, was obtained from the Research Ethics Committee (REC) of the College of Medical Sciences, University of Benin, to ensure compliance with ethical standards for animal experimentation.

Experimental Diets:

The experimental protocol involved the use of two distinct dietary regimes: a normal control diet (basal diet), comprising locally formulated pelleted grower's mash (19) (Table 1), and a specialized high-fructose experimental diet (Table 2) that is known to induce metabolic syndrome (20). The formulation of the experimental diet involved enriching the basal diet with a calculated proportion of white crystalline powdered D (-) Fructose, resulting in a diet composition with 60% fructose content (20). Furthermore, to support this dietary regimen, the rats were provided with drinking water containing 10% fructose (21).

Choice of Atorvastatin as the Reference Drug

Atorvastatin a known antihyperlipidaemic drug was chosen as the reference drug for this study. It was chosen, because it has been established that the pathogenesis of the anomalies (inflammation and oxidative stress) caused by a high fructose diet is majorly the direct consequence of the dyslipidaemia (increased in blood free fatty acids, hypercholesterolaemia and hypertriglyceridaemia) which the high fructose diet causes in the first place (1)(3). Fructose consumed in excess, ultimately affects the functions of the pancreas and the liver, via its activation of a dyslipidaemia that causes inflammation and oxidative stress (1)(3)(5).

Atorvastatin has been recommended by WHO, as an effective agent in the prevention of cardiovascular and metabolic diseases (11). Apart from its known antihyperlipidaemic effects which confers on it the ability to prevent cardiovascular and metabolic diseases, it has been shown to also have the ancillary effects of preventing the onset of inflammation and oxidative stress (11). Simvastatin and Atorvastatin meant for reduction of high cholesterol level, have been shown to induce a reduction of CRP and Malondialdehyde (MDA) in hyperlipidaemic states (12).

This study was not a diabetes, obesity or antioxidant study, so an anti-diabetic, anti-obesity or anti-oxidant drug, was not immediately the first drug of choice. It was a study done within the context of metabolic syndrome, induced by a high fructose diet. So a drug like Atorvastatin that could prevent both hyperlipidaemia, hyperglycaemia, insulin resistance, and other metabolic or physiological changes associated with metabolic syndrome, (which will mean, the prevention of inflammation and oxidative stress and the metabolic changes they cause, was therefore more relevant to this study.

Atorvastatin, in attempting to prevent the onset of dyslipidaemia in a scenario classical to metabolic syndrome induced by a high fructose diet, will prevent the onset of inflammatory and oxidative stress processes, which would have caused further damage to the body system. Considering all these, it was therefore chosen as the reference drug of this study.

Experimental Protocol:

Twenty male Wistar rats, about 7 weeks old, with weights ranging from 180g to 220g, were allocated randomly into four groups:

I. Group 1: Received the formulated pelleted grower's mash (basal diet) and clean tap water for 4 weeks (served as the normal control group).
II. Group 2: Received the 60% fructose diet (high fructose diet – HFD), supplemented with 10% fructose for 4 weeks (served as the negative control group).
III. Group 3: Received the 60% fructose diet (high fructose diet – HFD), supplemented with 10% fructose-water (FW) and Atorvastatin (0.57 mg/kg-b.w) for 4 weeks (served as the positive control group)
IV. Group 4: Received the 60% fructose diet (high fructose diet – HFD), supplemented with 10% fructose-water (FW) and Cellgevity® (26.15 mg/kg-b.w) for 4 weeks (served as the experimental group).

Dosage Regimen

The dosages of Cellgevity® and Atorvastatin were calculated based on established human doses and then adjusted according to the weight of the rats to ensure equivalence to the effective human dose (22)(23)(24).

For Cellgevity®: From the manufacturers recommendation and as established by previous studies, 1.83 g (2 capsules, 2 times daily) is usually consumed by a physiological man of 70,000 g man (70 kg) (15)(22)(23), this translates to a dose of 5.23 mg per 200 g, approximately 26.15×10^{-3} mg/g of rat (26.15 mg/kg of rat body weight).

For Atorvastatin: As established by the standard pharmaceutical doses and from previous studies, a physiological man of 70,000g man consumes 40mg of this drug daily (23)(25), a 200g rat would be expected to consume: Xmg = 40mg x 200g / 70,000g = 0.114mg (requiring the dissolution of 0.114mg of the drug in 1ml of distilled water). This translate to a dosage of 0.57×10^{-3}mg/g of rat, or 0.57mg/kg of rat body weight for a 200g rat.

Feeding Protocol

The feeding regimen involved providing the rats unrestricted access to food while carefully monitoring their daily consumption throughout the four-week research period. The rats were allowed a 12-hour light-dark cycle. The cages housing the rats were maintained by regular cleaning and disinfection procedures, to ensure a hygienic environment. The calculated quantity of Cellgevity® and Atorvastatin for the study, were dissolved in distilled water and the resulting solution refrigerated throughout the period of the study. The required quantity of Cellgevity® and Atorvastatin were retrieved from the refrigerator and brought to room temperature when needed. They were administered to the rats using an oro-gastric gavage.

Observations and Toxicity Assessment

Regular observations were conducted to detect any signs of toxicity, physiological alterations, or mortality among the animals. These assessments followed established methodologies from prior studies to ensure a thorough evaluation (26)(27).

Blood Sample Collection and Examination

After the 28th day of the study, blood samples were obtained via cardiac puncture, following an overnight fast, while the rats were under chloroform anesthesia. The samples were put in a lithium heparin bottle, centrifuged and then analysed for the inflammatory markers, high sensitive C-reactive protein (HsCRP), and oxidative stress indicators, malondialdehyde (MDA), and total antioxidant capacity (TAC).

Assessment of the High Sensitive C - reactive protein (HsCRP) levels:

The concentration of rat HsCRP was determined using a Sandwich-ELISA approach. The Rat high sensitivity C-reactive protein (Hs-CRP) ELISA kit by MyBioSource Incorporated USA, was used. The microtitre plate kit facilitated the measurement of HsCRP concentration by detecting the colorimetric reaction between antibodies and enzyme-conjugated compounds. The resulting color intensity at 450nm was directly proportional to the concentration of rat HsCRP (28).

Quantification of Malondialdehyde (MDA) Levels:

MDA levels, indicative of lipid peroxidation, were quantified spectrophotometrically using the

Thiobarbituric Acid Reactive Substances (TBARS) method (29). This involved the reaction between MDA and thiobarbituric acid under acidic conditions, resulting in the formation of a pink-colored product with maximum absorbance at 532nm (29).

Assessment of Plasma Total Antioxidant Capacity (TAC):

The evaluation of total antioxidant capacity was conducted using the Rat total antioxidant capacity (TAC) microplate assay kit manufactured by MyBioSource Incorporated, U.S.A. (30). This microplate assay kit measured the ability of antioxidants to reduce Fe^{3+}-TPTZ to Fe^{2+}-TPTZ complex, generating a colorimetric readout at 593nm. It provided insight into the remaining antioxidant capacity following oxidative stress (30).

Statistical Analysis:

Statistical significance was evaluated using ANOVA at a confidence level of 95%, followed by the Tukey's multiple comparison test. The statistical analysis was performed utilizing the SPSS-20 software package, with results deemed significant at $p<0.05$.

Results

The rats fed the high-fructose diet with 10% fructose water (negative control group) exhibited significant elevation ($P<0.05$) in both Hs-CRP and MDA levels, compared to the normal control rats (Table 3 and 4). Specifically, the Hs-CRP levels were 0.63±0.04 mg/dl in the negative control group, while the normal control group showed levels of 0.27±0.01 mg/dl. Similarly, the MDA levels were notably higher in the negative control group (0.32±0.01 μM) compared to the normal control group (0.10±0.01 μM).

Table 1: Composition of the normal/basal diet (g/1000g) based on of the standard pelleted growers mash of Jerrison Agro Allied Services, Benin City, Nigeria (20)

Ingredients	Basal diet (g
Maize	280.0
Wheat Offal	280.0
PalmKernel Cake	208.0
Soyabean Meal	48.0
Groundnut Cake	100.0
Fish Meal (65%)	12.0
Lysine	1.6
Bone Meal	12.0
Limestone	52.0
Methionine	0.8
Grower Premix	2.4
Salt	3.2
Total	**1000.0**

Both Atorvastatin and Cellgevity® effectively prevented the increase in Hs-CRP levels in their respective groups compared to the negative control, with levels of 0.28±0.00 mg/dl for the Atorvastatin group and 0.29±0.01 mg/dl for the Cellgevity® group (Table 3 and 4). These values were significantly lower ($P<0.05$) than those of the negative control group. While Cellgevity® significantly attenuated the rise in MDA levels compared to the negative control, with a level of 0.09±0.02 μM (Table 4), Atorvastatin on the other hand though it reduced the level of increase in MDA, its effect was not statistically significant ($P>0.05$).

Table 2: Composition of the 60% high fructose diet (metabolic syndrome-inducing) diet (g/1000g)

Ingredients	High -Fructose Diet (g)
Basal diet in Table 1	400.0
Pure white crystalline powdered Fructose	600.0
Total	**1000.0**

The high-fructose diet with 10% fructose water led to a significant reduction ($p<0.05$) in TAC levels compared to the normal control rats (Table 5). The TAC levels were 0.21±0.06 μmol/ml in the negative control group, whereas the normal control group exhibited levels of 0.42±0.03 μmol/ml. Both Atorvastatin and Cellgevity® significantly ($P<0.05$) mitigated this decrease in their respective groups compared to the negative control group, with TAC levels of 0.38±0.03 μmol/ml for the Atorvastatin group and 0.59±0.03 μmol/ml for the Cellgevity® group. Notably, Cellgevity® induced a remarkable and significant increase in TAC when compared to the Atorvastatin and normal control groups, highlighting its potent antioxidant effects (Table 5).

Table 3: High sensitive C-reactive protein (Hs-CRP) levels of the rats fed high-fructose diet

Groups	Hs-CRP (mg/dl)
Group 1 (Control)	0.27 ± 0.01^{a}
Group2 (HFD+FW)	$0.63\pm0.04^{b,c}$
Group 3 (HFD+FW + Atorvastatin)	$0.28\pm0.00^{a,d,e}$
Group 4 (HFD+FW + Cellgevity®)	$0.29\pm0.01^{a,d,e}$

All research results are expressed as mean ± SEM (= standard error of the mean) of five determinations (n=5) and subjected to one-way analysis of variance (ANOVA). Means in the same column with different superscript alphabets on the same position, differ significantly at 95% level of significance (p <0.05) using Turkey's test of significance.

HFD+FW: High fructose diet + fructose water.

MDA: Malondialdehyde.

Hs-CRP: High sensitive C-reactive protein.

TAC: Total antioxidant capacity.

Table 4: Malondialdehyde (MDA) levels of the rats fed high-fructose diet

Groups	MDA (μM)
Group 1 (Control)	0.10±0.01[a]
Group 2 (HFD+FW)	0.32±0.01[b,c]
Group 3 (HFD+FW + Atorvastatin)	0.17±0.10[a,c,e]
Group 4 (HFD+FW + Cellgevity®)	0.09±0.02[a,d,f]

All research results are expressed as mean ± SEM (= standard error of the mean) of five determinations (n=5) and subjected to one-way analysis of variance (ANOVA). Means in the same column with different superscript alphabets on the same position, differ significantly at 95% level of significance (p <0.05) using Turkey's test of significance.

Table 5: Total antioxidant capacity (TAC) levels of the rats fed high-fructose diet

Groups+	TAC (μmol/ml)
Group 1 (Control)	0.42±0.03[a]
Group 2 (HFD+FW)	0.21±0.06[b,c]
Group 3 (HFD+FW + Atorvastatin)	0.38±0.03[a,d,e]
Group 4 (HFD+FW + Cellgevity®)	0.59±0.03[b,d,f]

All research results are expressed as mean ± SEM (= standard error of the mean) of five determinations (n=5) and subjected to one-way analysis of variance (ANOVA). Means in the same column with different superscript alphabets on the same position, differ significantly at 95% level of significance (p <0.05) using Turkey's test of significance.

Discussion

This study set out to explore the preventive potential of Cellgevity® against high fructose diet-induced inflammation and antioxidant imbalance in rats. To achieve this, the impact of a high fructose diet (HFD) combined with 10% fructose water (FW) on markers of inflammation, oxidative stress, and antioxidant capacity in rats, were investigated alongside the effect that will be seen with the co-administration of Atorvastatin and Cellgevity®. Group 2, the negative control group, exposed to HFD+FW, exhibited a significant increase (P<0.05) in high sensitive C-reactive protein (Hs-CRP) and malondialdehyde (MDA) levels compared to the normal control group (Group 1). This finding is consistent with earlier reports indicating that high fructose intake induces inflammation and oxidative stress (2, 13, 31), with supporting evidence from studies demonstrating the impact of high-fructose diet on gut microbiota composition and intestinal permeability (31). Other results of this study for Group 2 rats (not shown here) confirms metabolic changes in them. These changes include, hypercholesterolaemia and hypertriglyceridaemia, along with hyperglycaemia, hyperinsulinaemia and insulin resistance.

This study also showed that intervention with Atorvastatin and Cellgevity® had promising outcomes in mitigating these effects. They significantly prevented the increase in the levels of the inflammatory marker, Hs-CRP, in the rats of the respective groups they were fed with, compared to the rats of negative control group. This indicates that Cellgevity® as constituted by its manufacturers, has the potential of reducing inflammation induced by the high fructose diet. Hs-CRP, is an acute phase protein, that plays a crucial role in innate immune responses and its elevation is strongly associated with hypertension, cardiovascular risk, pre-diabetic states and in diabetes mellitus (13). The prevention of Hs-CRP elevation by Cellgevity® suggests that it plays a role in averting inflammatory responses and subsequent endothelial dysfunction that is normally associated with high fructose diet-induced, metabolic syndrome.

The ability of Cellgevity® to prevent an increase in Hs-CRP levels may be attributed to its blend of bioactive herbal ingredients and phytochemicals, from its constituent, turmeric Extract, resveratrol, quercetin, and grape seed extract, all of which have been shown to have anti-inflammatory, antioxidant defense, antihyperlipidaemic and cellular protection properties (13, 15, 32).

Interestingly, while the negative control group exhibited a significant increase in MDA levels and a decrease in total antioxidant capacity (TAC) compared to the normal control group, the intervention with Cellgevity®, significantly prevented (P<0.05) the increase in MDA levels and inhibited the decrease in TAC levels compared to the negative control group. Atorvastatin on the other hand also prevented this increase in MDA levels, though not in a statistically significant manner (P>0.05). It also significantly prevented (P<0.05) a decrease in TAC levels. It is also noteworthy that Cellgevity® not only prevented the decrease in TAC levels, it also caused a marked increase (P<0.05) in the TAC levels in the experimental group, compared to the level in the rats of the normal control group. This highlights the potent ability of Cellgevity®, to increase the antioxidant capacity in animals.

Oxidative stress, characterized by increased MDA levels from increased lipid peroxidation, can lead to negative cardiovascular events and contribute to the development of metabolic syndrome and metabolic diseases like diabetes mellitus (32, 33). Cellgevity®'s ability to prevent an increase in MDA levels and a decrease in TAC levels may be attributed to its constituents, including RiboCeine and other constituents with antioxidant properties like vitamin C, selenium, and alpha-lipoic acid. These components contribute to its strong antioxidant benefits, as established from earlier research and as highlighted by its manufacturers as enhancers of glutathione levels (32, 33). The ability of Cellgevity® to prevent oxidative stress induced by the high fructose diet underscores its potential in protecting against negative cardiovascular events and the development of metabolic syndrome and metabolic diseases like diabetes mellitus, which can be precipitated by high oxidative stress inducing events.

Conclusion

The results of this study highlighted the potential therapeutic role of Cellgevity® as a preventive adjuvant, in combating inflammation and oxidative stress, induced by high fructose intake. By targeting the prevention of inflammation and oxidative stress, Cellgevity® may offer protective effects against the development of metabolic syndrome and related cardiovascular and metabolic complications, which are often the result of the detrimental effects of a high fructose diet. It has become more important that something is done to mitigate this diet induced disorders, especially in the context of the current westernization of our diet and fast rising sedentary lifestyle. Further research is warranted to further elucidate the therapeutic role of Cellgevity®'s in combating metabolic disorders in humans.
Overall, this study contributed to the growing body of evidence supporting the use of Cellgevity® as a potential adjuvant therapy in addressing the adverse effects of high fructose diet-induced inflammation and antioxidant imbalance, paving the way for future investigations into its therapeutic applications.

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Institutional Review Board/ethical Clearance

The study was conducted according to the guidelines of the international protocols on care of animals promoted by the Canadian Council on Animal Care, (1984), and was approved and given ethical clearance by the Research Ethics Committee (REC) of the College of Medical Sciences, University of Benin. The REC Approval Number being: CMS/REC/2023/485.

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Conflict of Interest

The authors declare no conflict of interest.

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