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Morphological Effects of Long Term Consumption of Energy Drink on the Kidney of Adult Wistar Rats.

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ABSTRACT

Morphological effects of long term consumption of energy drink commonly use as flavored beverage drinks on the kidney of adult wistar rats was carefully studied. The rats of both sexes (N = 20), with average weight of 200g were randomly assigned into treated(n1=10) and control (n2=10) groups. The rats in the treated group received energy drink on a daily basis for 10hrs and 14hrs of distilled water liberally in thirty days, while the control group received equal amount of distilled water daily for thirty days. The growers mash feeds was obtained from Edo Feeds and Flour Mill Limited, Ewu, Edo state, Nigeria and the rats were given feeds liberally. The rats were sacrificed by cervical dislocation on the thirty-first days of the experiment; the kidneys were carefully dissected out, weighed and quickly fixed in 10% formal saline for further histological study. The findings indicated that there was a significant ($p < 0.05$) increase in left kidney weight (g) of the treated group as compared to the control group. The histological findings revealed that the treated group showed some level of distortion and disruption of the cytoarchitecture of the renal cortical structures. The treated renal cortical structures was associated with an enlarged Bowman's space, distortion of the glomerular capsule, diffuse glomerulonephritis, and some marked signs of tubular distortion and necrosis as compared to the control group. Long term consumption of energy drink may therefore have an adverse effect on the cytoarchitecture and functions of the kidney of adult wistar rats. It was thereforerecommended that further studies aimed at corroborating these observations be carried out.

Key words: Morphology effects, Energy drink, Kidney, Wistar rats.

INTRODUCTION

Energy drinks are flavored beverages containing high amounts of caffeine and typically other additives, such as vitamins, taurine, herbal supplements, creatine, sugar, and guarana, a plant product containing concentrated caffeine. The energy drinks are marketed to improve energy, weight loss, stamina, athletic performance, and concentration [1, 2, 3]. These drinks sold in cans and bottles, are readily available in grocery stores, vending machines, convenience stores, bars and other venues where alcohol is sold. Consumption of energy drinks is a rising public health problem because medical and behavioural consequences can result from excessive caffeine intake. A growing body of scientific evidence documents harmful health effects of energy drinks, particularly for children, adolescents, and young adults [4]. Research has established that among college students, there are associations between energy drinks consumption and problematic behaviours such as marijuana use, sexual risk taking, fighting, smoking, drinking and prescription drug misuse [5, 6]. Although healthy people can tolerate caffeine in moderation, heavy caffeine consumption, such as drinking energy drinks, has been associated with serious consequences such as seizures, mania, stroke and sudden death [7, 8, 9, 10,11,12,13]. In children especially those with cardiovascular, renal, or liver disease, seizures, diabetes, mood and behaviour disorders, hyperthyroidism or those who take certain medications may be at higher risk for adverse events from energy drinks consumption [13, 14; 15; 16; 17; 18; 19; 20; 21; 22; 23]. However, caffeine has been reported to have detrimental health consequences. Riesenhuber and colleagues found that the caffeine but not taurine in energy drinks promotes diuresis and natriuresis [24]. Further acute caffeine consumption reduces insulin sensibility [25] and increases mean arterial blood pressure [26]. High caffeine consumption is associated with chronic daily headaches, particularly among young women and among those with chronic episodic headaches and of recent onset [27]. Central nervous system, cardiovascular, gastrointestinal, and renal dysfunction have been associated with chronic caffeine ingestion [28]. Aspartame is a synthetic sweetener and preservatives, which is of low caloric value added to soft drinks, chewing gum, fruit juices, gelatins and jellies [29, 30]. Aspartame is metabolized in the gastrointestinal tract into aspartic acid, methanol, and phenylalanine [31]. The methanol is later oxidized to formaldehyde and formate in many tissues. Formic acid is the principal metabolites responsible for the deleterious effects of acute intoxication by methanol in humans and animals [32]. It causes blindness and loss of hepatic function since the liver and retina concentrate, the greatest quantity of byproducts of aspartame during intoxication [33].

The kidney is a paired organ located in the posterior abdominal wall, whose functions include the removal of waste metabolic products from the blood and regulation of water and electrolytes balance in the body. In human, majority of drugs administered are eliminated by the combination of hepatic metabolism and renal excretion[34]. Since the kidney is involved in the excretion of many toxic metabolic waste products, particularly the nitrogenous compounds in the body, it would therefore be worthwhile to examine the effects of energy drink consumption on the morphology of the kidney using the adult wistar rats.

MATERIALS AND METHODS

ANIMALS: The ethical committee of the Achievers University, Owo granted the approval before the commencement of the research. Twenty adult wistar rats of both sexes (Animals were caged based on same sex to avoid mating and pregnancy) with average weight of 200g were randomly assigned into two groups: A and B of (n=10) in each group. Animals in group A served as treated group (n1=10) while animals in group B (n2=10) served as the control. The rats were obtained and maintained in the Animal Holding of the Department of Medical Laboratory Science, College of Natural and Applied Sciences, Achievers University, Owo, Ondo State, Nigeria. The animals were fed with grower's mash obtained from Edo Feeds and Flour Mill Limited, Ewu, Edo State, Nigeria and given feeds liberally. The energy drinks were obtained from retailer store, Owo, Ondo State, Nigeria.

ENERGY DRINK CONSUMPTION: The rats in the treated group received energy drinks and distilled water alternatively on a daily basis for 10hrs and 14hrs liberally in thirty days, while the control group received distilled water liberally for the thirty days in line with an improved method described in previous studies [35]. The ingredients contained in the energy drink are as follows: Water, Citric acid, Carbon dioxide, Taurine (0.38%), acidity regulator (Sodium citrate), Sweeteners (Acesulfame and Aspartame), Flavouring, Caffeine (31.5mg), Glucoronolactone (0.01%), Nicotinamide (7.92mg/100ml, 49.5% RDA) Colour ammonia caramel, inositol, Niacin, Pantothenic acid (33% RDA, about 1.98/100ml), vitamin B6 (143% RDA about 2mg/100ml) vitamin B12 (80% RDA, 2ug/100ml). The rats were sacrificed by cervical dislocation on the thirty-first day of the experiment and the kidney was extracted, weighed and quickly fixed in 10% formal saline for routine histological techniques.

HISTOLOGICAL STUDY: The tissues were dehydrated in an ascending grade of alcohol (ethanol), cleared in xylene and embedded in paraffin wax. Serial sections of 7 microns thick were obtained using a rotatory microtome. The deparaffused sections were stained routinely with haematoxyline and eosin 36. Photomicrographs of the desired results were obtained using research photographic microscope in the Department of Medical Laboratory Science, College of Natural and Applied Sciences, Achievers University, Owo, Ondo State, Nigeria.

RESULTS

The findings indicated an increase in the weights (g) of both kidneys with that of the left kidney statistically significant ($p < 0.05$) in the treated group as compared to the control group (Table 1). The photomicrograph of the kidney in the control group showed normal histological features with detailed cortical parenchyma and the renal corpuscles appearing as dense rounded structure with the glomerulus surrounded by a narrow Bowman's spaces with distinct glomerular capsules (figure 1), while the section of the treated kidney showed some level of distortion and disruption of the cytoarchitecture of the renal cortical structures. The treated renal cortical structures was associated with an enlarged Bowman's space, distorted glomerular capsule, diffuse glomerulonephritis, and some marked signs of tubular distortion and necrosis as compared to the control group

Table 1: The Mean SEM Weight (g) and Relative Weight (%) of the Kidney of the Animals.

PARAMETERS	GROUP OF ANIMALS	
	CONTROL ($n_1 = 10$)	TREATED ($n_2 = 10$)
Body weight (g)	*191.43 ± 7.549	*217.860 ± 5.515
Right Kidney weight (g)	0.573 ± 0.021	0.609 ± 0.031
Relative Right Kidney weight (%)	0.301 ± 0.008	0.281 ± 0.103
Left Kidney weight (g)	*0.538 ± 0.024	*0.642 ± 0.036
Relative Left Kidney weight (%)	0.282 ± 0.008	0.295 ± 0.110

*Significant (P< 0.05)

Histology

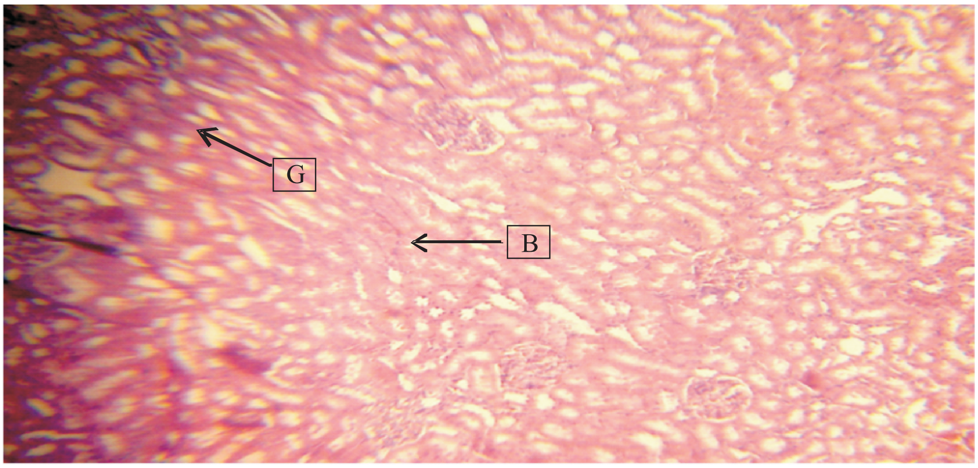

Figure 1: Control section of the Kidney showing the Glomerulus (G) and Bowman's space (B). (H & E x100)

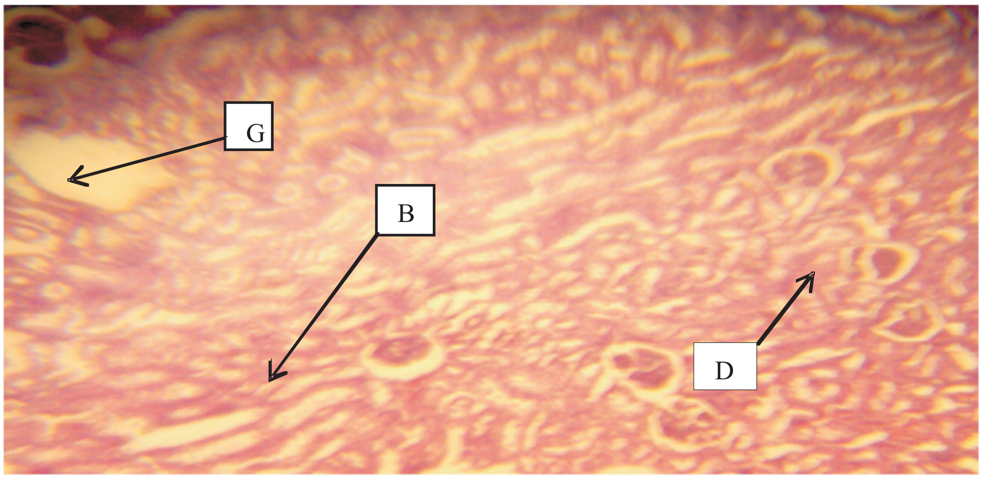

Figure 2: Tested section of kidney showing diffuse glomerulonephritis (G), dilated Bowman's space (B) and distorted glomerulus (D). (H & E Method x100)

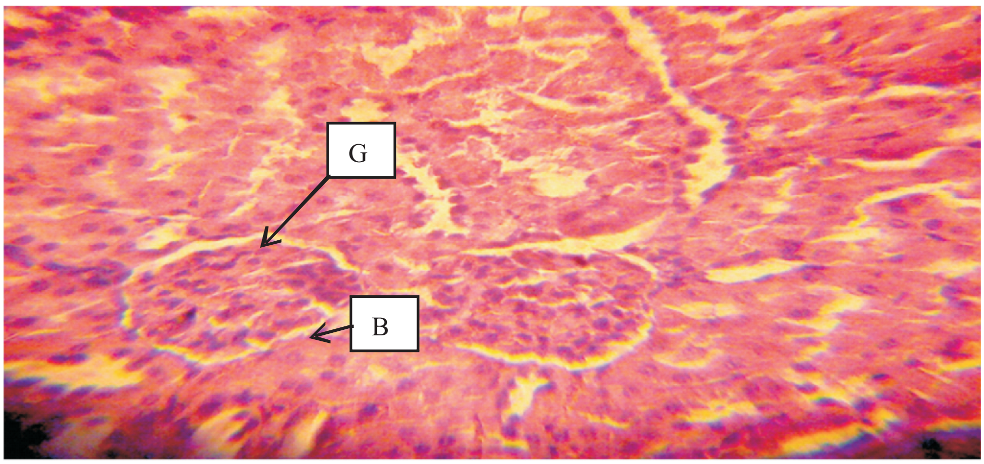

Figure 3: Control section of the Kidney showing the Glomerulus (G) and Bowman's space (B). (H & E x400)

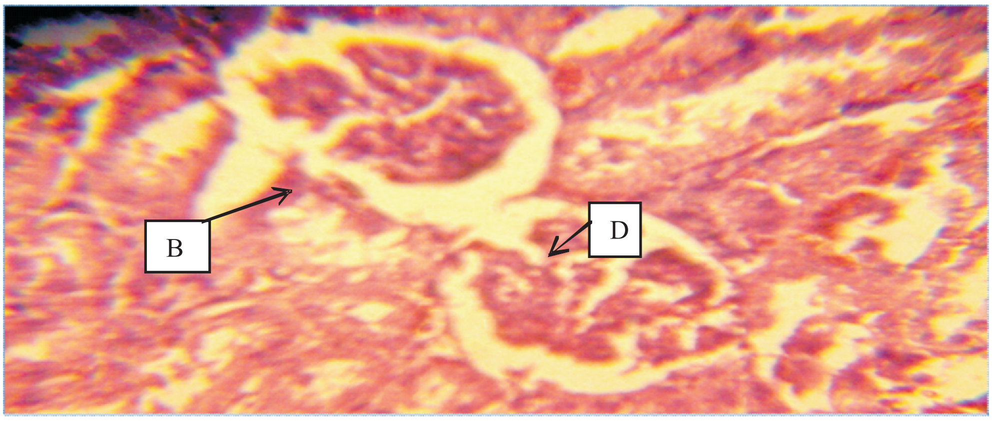

Figure 4: Tested section of kidney showing, dilated Bowman's space (B) and distorted glomerulus (D). (H & E Method x400)

DISCUSSION

The findings of this experiment indicated an increase in the weights (g) of both kidneys with that of the left kidney statistically significant ($p < 0.05$) in the treated group as compared to the control group. The sections of the photomicrograph of the kidney in the treated group also revealed some level of distortion and disruption of the cytoarchitecture of the renal cortical structures as compared to the control. The treated renal cortical structures was associated with an enlarged Bowman's space, distorted glomerular capsule, diffuse glomerulonephritis, and some marked signs of tubular distortion and necrosis as compared to the control group.

The significant ($p < 0.05$) increase observed in left kidney weight (g) of the treated group in this experiment as compared to the control group may be due to the cytotoxic effects of energy drink. As tissue swells and as seen in this study, the activities of the cellular transporters are approximately modified by the up or down regulations as has been reported in the case of hyponatramia or hypernatremia [37]. Ischemia or pharmacologic disruption of cellular transporters can cause swelling of parenchyma of any organ, and this is supported by the current study. The pharmacologic disruption of the body and increase in weights of the kidneys caused by energy drink is a cardinal feature of the results of this experiment. However, there are many different causes of cell swelling or shrinkage, including drug poisoning, water intoxication, hypoxia, and acute hyponatremia leading to a net shift of water from the extracellular space to the interior of the cells [37]. The significant increase associated with the weight of the left kidney in this experiment may be involved in the intracellular swellings or shrinkage of the endothelia of the treated group [37].

The distortion and disruption of the cytoarchitecture of the kidney observed in this experiment may have been associated with some functional changes that could be detrimental to the health status of the animals. The obvious signs of the marked diffuse glomerulonephritis and some marked signs of tubular distortion and necrosis observed in this experiment may have been due to the cytotoxic effects of the energy drink on the microanatomy of the kidney. These findings implicated long-term consumption of energy drink as a possible precipitant of kidney disease by causing distortion and disruption of the renal cortical structures in the microanatomy of the kidney. Pathological or accidental cell death is regarded as necrotic and could result from extrinsic insult to the cell as osmotic, thermal, toxic and traumatic effects [39]. The process of cellular necrosis involves disruption of membranes, as well as structural and functional integrity. In cellular necrosis the rate of progression depends on the severity of the environmental insults. The greater the severity of the insults, the more rapid the progression of neuronal injury[39]. The principle holds true for toxicological insult to the brain and other organs [40]. It may be inferred from the present study that prolonged consumption of energy drink may have resulted in the toxic effects on the kidney. The result obtained in this experiment is in consonance with the work carried out by Adjene et al., (2010) where it was reported that chronic consumption of soda pop drinks resulted in some varying degree of distortion and disruption of the cytoarchitecture of the renal cortical structures, diffuse glomerulonephritis with some congestion and tubular necrosis in the microanatomy of the treated kidney of adult wistar rats as compared to their corresponding control [35]. In this experiment, energy drink may have acted as toxin to the cells of the kidney thus resulting in an enlarged Bowman's space, distorted glomerular capsule, diffuse glomerulonephritis, and some marked signs of tubular distortion and necrosis. Enaibe et al., (2007) reported that administration of camphor resulted in mild edema with glomerulonephritis, glomerular lobulation, tubular necrosis and congestion of blood cell in the kidney of rabbit [41]. Administration of damiana (Turnera diffusa) to a matured wistar rats has been reported to have resulted in the distortion of the renal cortical structures, reduced size and number of the renal corpuscles and some degree of cellular necrosis in the histology of the kidney [42]. Chronic administration of aqueous extract of alchornea cordifolia leaf to an adult wistar rats resulted in a significant decrease in weight, distortion and disruptions of the cytoarchitecture of the renal cortical structures with marked diffuse glomerulonephritis and an enlarged Bowman's space [43, 44].

CONCLUSION AND RECOMMENDATION: In conclusion, our findings indicated that long-term consumption of energy drink resulted in a significant ($p < 0.05$) increase in the weight (g) of the left kidney of the treated group and some level of distortion and disruption of the cytoarchitecture of the renal cortical structures as compared to the control. The treated renal cortical structures was associated with an enlarged Bowman's space, distorted glomerular capsule, diffuse glomerulonephritis, and some marked signs of tubular distortion and necrosis as compared to the control group. With these results, it is probable that the functions of the kidney may be adversely affected. We therefore recommend that further studies aim at corroborating these observations be carried out.

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