

Histopathological Effect of Energy Drinks (Red Bull) on Brain, Liver, Kidney, and Heart in Rabbits

Nadia Abdulkarim Salih, Israa Hameed Abdul-Sadaand¹, Nawzad Rasheed Abdulrahman¹

Departments of Basic Sciences and ¹Anatomy and Histopathological, College of Veterinary Medicine, Sulaimani University, Kurdistan, Iraq

Abstract

Background: Red bull has been known as a healthy drink within many populations. The chemical composition of energy drinks can produce multiple adverse effects, including serious behavioral effects. **Objective:** To study the effect of energy drinks (Red Bull) on brain, liver, kidney, and heart in rabbits. **Methods:** thirty males albino rabbits were used, animals divided into 3 groups (A, B, and C), each group contain 10 rabbits. Group A treated with high dose of red bull (10 cc), Group B treated with low dose (5 cc), and Group C is control group. **Results:** The results showed that control group had no any pathological changes while both Groups A and B showed many pathological changes, Group A showed renal vascular congestion, hemorrhage of interstitial tissue, focal atrophy, and degeneration of lining epithelium of proximal and distal convoluted tubules, while Group B showed renal vascular congestion, glomerular capillary congestion, hemorrhage of interstitial tissue with swelling of lining epithelium of proximal and distal convoluted tubules that appeared as pale cytoplasm with star-shaped lumen, and swelling of glomeruli; this reveals that there is dose-response relationship between treated groups with low and high dose of red bull. **Conclusion:** Energy drinks have dose-response relationship with adverse effect; it has become apparent that the consumption of these energy drinks will seriously harm the body.

Keywords: Energy drinks, histopathological effect, red bull, taurine

INTRODUCTION

Red bull has been known as a healthy drink within many populations. The chemical composition of energy drinks can produce multiple adverse effects, including serious behavioral effects. Individuals drinks red bull to feel energized during the day. The effects of the drink are likely achieved by the amounts of added caffeine and sugar.^[1,2]

Simple sugars are metabolized by the body and produce a quick energy burst, followed by a deep energy deficit. High intake of sugar raises blood fat levels and leeches essential minerals such as copper, chromium, and zinc from the body, leading to deficiency diseases, immune system impairment, and even insulin resistance.^[3]

In animals, taurine can produce a decrease in body weight (a sign of toxicity) and dehydration. In rats and guinea pigs, high intake is associated with liver dysfunction. Small doses of taurine can enhance the toxicity of industrial pollutants such as carbon tetrachloride.^[4]

Glucuronolactone

It is a naturally occurring substance manufactured by the human body. Rats metabolize this substance differently from humans and other mammals.

Caffeine is a stimulant which increases heart rate and blood pressure and raises the level of harmful stress hormones in the bloodstream. In high doses, caffeine is dehydrating, addictive and can reduce adrenal function and the body's immune response. In pregnant women, high caffeine intake is associated with increased risk of miscarriage.

Synthetic flavorings can be mixes of several industrial chemicals and it can be considered as neurotoxins, allergens, and potential carcinogens.^[5]

Address for correspondence: Dr. Nadia Abdulkarim Salih, Department of Basic Sciences, College of Veterinary Medicine, Sulaimani University, Kurdistan, Iraq.
E-mail: nadiasalih9@gmail.com

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Caramel produced by ammonia process is a common food coloring. This type of coloring has been associated with blood toxicity in rats. There is evidence that it may damage genes and cause enlargement of the intestines and kidneys.^[1]

MATERIALS AND METHODS

Thirty male albino rabbits were chosen in this experiment; all the animals were kept in properly cages with suitable environment in laboratory animals and fed a balance diet provided with Vitamin C and drunk enough amount of water during all the period of experiment; after 1 week of the settlement, all the animals were weighed.

The rate of the animals weights was 500 g–1.3 kg, all the animals were divided into three groups, each group contain 10 rabbits (A, B, C), two groups (A and B) for dosage groups, and the last group (C) for the control.

The Group A (high dosage) group contain ten rabbits, all of them administrated with Red Bull (10 ml) by gavage needle for 30 days. The other group (Group B) (low dosage) contains ten rabbits administrated with Red Bull (5 ml) by gavage needle for 30 days. While for the control group were administrated distal water during all the period of the study which is 30 days. After the end term of the experiment, each animal in all groups were killed by a high dose of general anesthesia with ketamine (35 mg/kg) and xylazine (5 mg/kg) given I/M.

Organs such as liver, brain, kidney and heart were isolated and putted in formalin 10% for 24 h, followed the automated tissue processing for preparation the slides all the slides were stained with Hematoxylin and Eosin stain.

RESULTS

The results showed that control group Figure 1 had no any pathological changes while both group A and B showed many pathological changes Figures 2 and 3, group A showed renal vascular congestion, hemorrhage of interstitial tissue, focal atrophy and degeneration of lining epithelium of proximal and distal convoluted tubules while group B showed renal vascular congestion that appeared as pale cytoplasm with star shaped lumen and swelling of glomeruli. Figure 4 showed normal liver structure in control group while Figures 5 and 6 show abnormal changes due to harmful effect of red bull like congestion of sinusoidal swelling of hepatocyte and many centrilobular leukocyte infiltration. The results showed that the brain in control group had no any pathological changes [Figure 7] while Figures 8 and 9 showed the effect of red bull on the rabbits brain and caused neuronal degeneration and aggregation of focal plaque. The results also showed that the rabbit heart in control group had no any pathological changes [Figure 10] while Figures 11 and 12 showed the effect of treatment with red bull on heart and caused mild muscle necrosis and edema of purkinje fibers.

DISCUSSION

Red bull drinks have many side effects and each 250 ml or a can of Red Bull contains the following: 1000 mg of taurine, 600 mg of glucuronolactone, 80 mg of caffeine, 18 mg of niacin (niacinamide), 2 mg of Vitamin B6, 6 mg of pantothenic acid (calcium d-pantothenate), Vitamin B2 (riboflavin), Vitamin B12 (cyanocobalamine), inositol, and nonmedicinal ingredients: carbonated water, sucrose, glucose (27 g of sugar), citric acid, flavors, and caramel.^[6]

Taurine is not essential for humans, and it should only be recommended under supervision of a physician; since glucuronolactone is a precursor to taurine, the body manufactures glucuronolactone naturally.^[5,7]

Energy drinks increase blood pressure, heart rate or alter glycemic levels; these can often prevent normal sleep cycles and may have more serious effect on dehydrated athlete by increasing the heart rate.^[8] In 2000, Ross Cooney, a healthy, 18-year-old basketball player from Limerick, Ireland, collapsed on the court and died after drinking four cans of Red Bull before a basketball game, he died as a result of Sudden Arrhythmia Death Syndrome.^[9]

“gives you wings” is the promises that energy drink companies attract consumers; according to Red Bull, all of the ingredients are synthetically produced by pharmaceutical companies, which “guarantees the highest quality” of ingredients, the company claims the combination of caffeine, taurine, and glucuronolactone will boost energy.^[10]

The biosynthesis of taurine occurs in the liver through the cysteine sulfinic acid pathway. The mean intake in humans is estimated to be around 60 mg daily. Premature infants lack the enzyme to convert cystine and synthesize taurine and may become deficient in taurine. Therefore, for the premature infant, taurine is a dietary essential nutrient often found as a supplement in baby formulas and baby foods.^[11]

Some countries (France, Denmark, and Norway) originally banned energy drinks because of their taurine content but have since accepted that taurine consumption is safe based on the evidence to date.^[2,12]

Energy drinks has potential adverse effects which attributed to the presence of caffeine. It has been found that large doses of caffeine (3 mg/kg) may lead to health problems such as impaired glucose tolerance, gastrointestinal irritation, anxiety, irritability and nausea, and tachycardia, suggesting that a lower dose of caffeine should be investigated.^[13,14]

Most of energy drinks are considered unhealthy for the human body; therefore, these drinks should be watched carefully due to the unbalanced ingredients, especially sugar and caffeine in their compositions.^[4]

People drink red bull to obtain energy to perform activities, workout tiredness, or to finish job responsibilities. General public should not use energy drinks while exercising as the combination of all the stimulants and other ingredients in

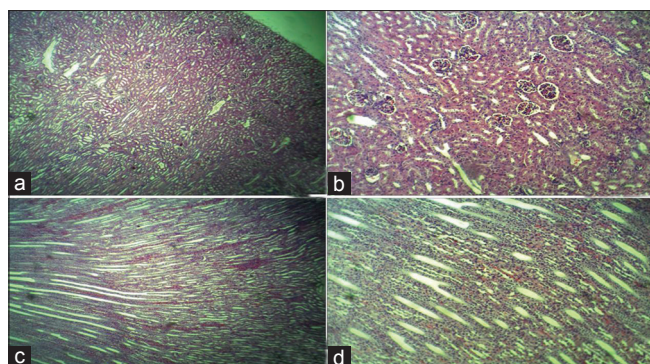


Figure 1: Photomicrograph of the kidney in control group show: (a and b) normal histological structure of glomeruli, proximal, and distal convoluted tubules (H and E, $\times 40$, $\times 100$). (c and d) Normal structure of ascending and descending loops of Henle (H and E, $\times 40$, $\times 100$)

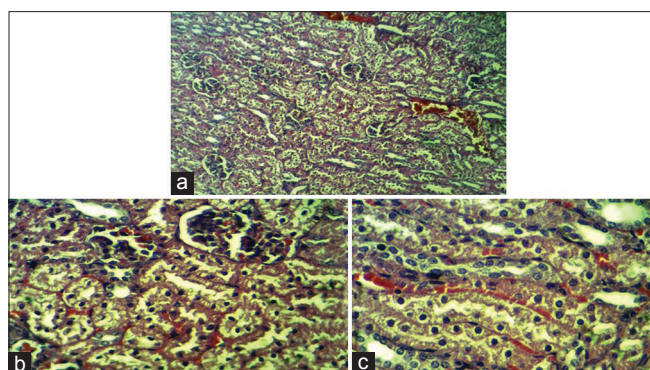


Figure 3: Photomicrograph of kidney in the high dose-treated group show (a and b) renal vascular congestion, hemorrhage of interstitial tissue, focal atrophy and segmentation or lobulation of glomerular capillary with degeneration of lining epithelium of proximal and distal convoluted tubules that remain only faint cytoplasm and nuclei (H and E, $\times 100$, $\times 400$) (c) Hemorrhage of interstitial tissue with degeneration of lining epithelium of Henle loops and fuzzy cytoplasm, (H and E, $\times 100$, $\times 400$)

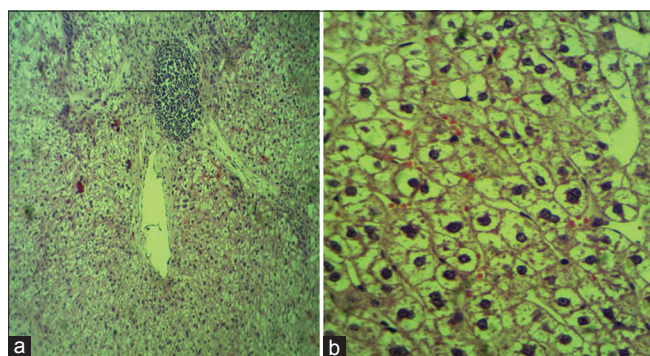


Figure 5: Photomicrograph of liver in the low dose-treated group show (a) central vein dilation, focal centrilobular Leukocyte infiltration, and ballooning degeneration of hepatocytes (H and E, $\times 100$). (b) High magnification of section shows severe hydropic degeneration; ballooned hepatocytes enlarged with diluted cytoplasm and eccentrically located nuclei (H and E, $\times 100$, $\times 400$)

energy drinks can result in a loss of fluid from sweating and cause severe dehydration and serious health problems.^[15,16]

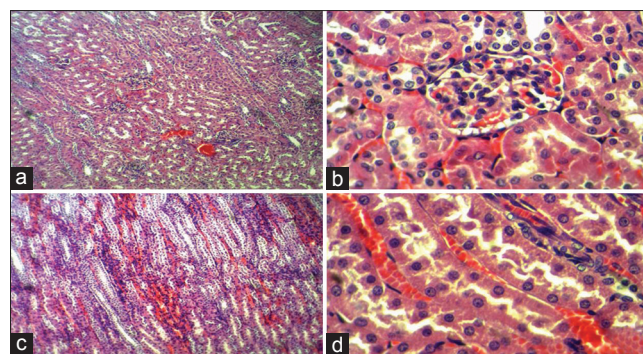


Figure 2: Photomicrograph of kidney in the low dose-treated group show (a and b) renal vascular congestion, glomerular capillary congestion, hemorrhage of interstitial tissue with swelling of lining epithelium of proximal and distal convoluted tubules that appeared as pale cytoplasm with star-shaped lumen, and swelling of glomeruli only remained a thin rim of Bowman's capsule, (H and E, $\times 100$, $\times 400$). (c and d) Hemorrhage of interstitial tissue with swelling of lining epithelium of Henle loops; blurred cytoplasm with the variable degree of swelling that form a star-shaped structure, (H and E, $\times 100$, $\times 400$)

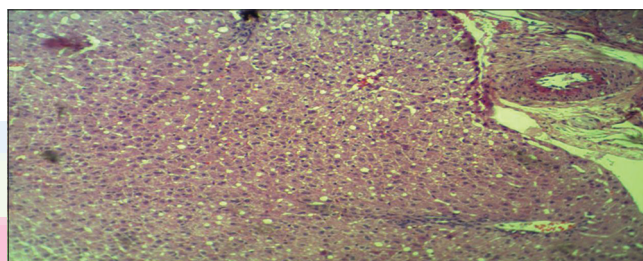


Figure 4: Photomicrograph of liver control group shows the normal histological structure of central vein and portal area with the normally arranged plate of hepatocytes (H and E, $\times 100$)

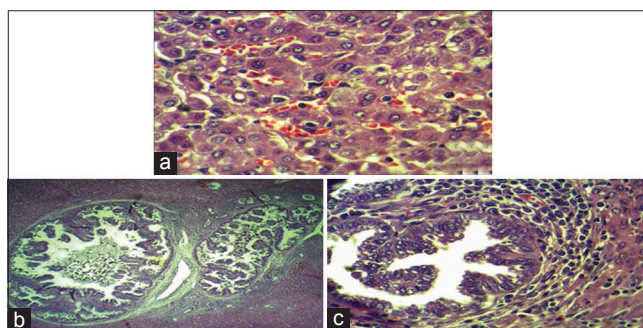


Figure 6: Photomicrograph of liver in the high dose-treated group show (a) congestion of sinusoidal capillaries. Hydropic swelling; swelling of hepatocytes 2–3 times than the normal that leads to narrowing of the sinusoidal capillary with pale cytoplasm and centrally located nuclei (H and E, $\times 400$). (b and c) Hyperplasia of the bile duct in the portal area; the proliferation of newly forming bile ductile that forming gland-like or finger projection toward the lumen with peri-infiltration of mononuclear inflammatory cells (H and E, $\times 40$, $\times 100$)

Taurine may be involved in interactions with GABAergic, glycinergic, cholinergic, and adrenergic neurotransmitter system. It is widely known that caffeine blocks adenosine

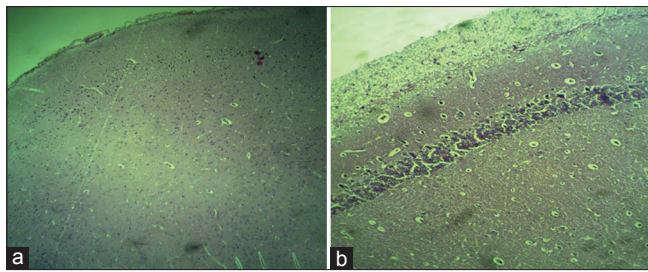


Figure 7: Photomicrograph of the brain in control group show (a) normal cerebral cortex histological structure. (b) Normal hippocampus structure (H and E, $\times 40$, $\times 100$)

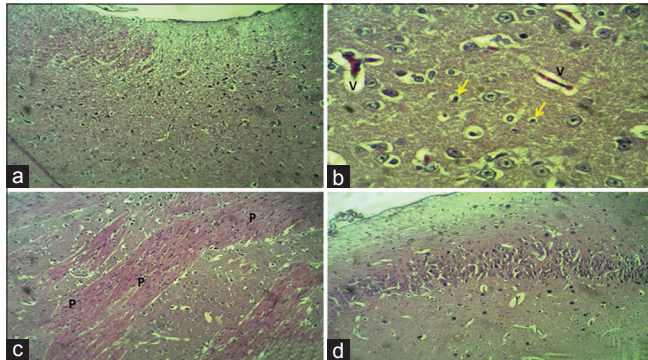


Figure 9: Photomicrograph of brain in high dose-treated group show (a) slightly neuronal degeneration of the cerebral cortex. (b) Necrotic changes of neurons in the cerebral cortex having a shrunken form with small pyknotic nuclei indicated by yellow arrows with cerebral vascular congestion that indicated by v letters. (c) Aggregation of focal eosinophilic plaques (P) (d) hippocampus show moderately decreasing the number of neuronal cells (H and E, $\times 100$, $\times 400$, $\times 100$ and $\times 100$)

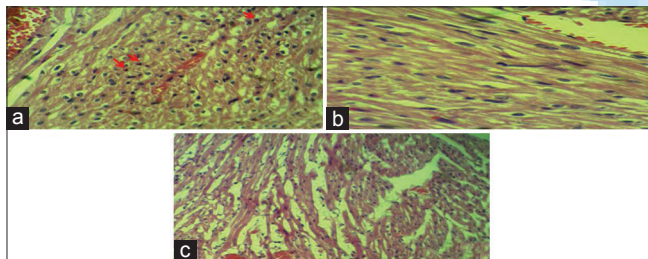


Figure 11: Photomicrograph of heart in low dose-treated group show (a) mild muscle necrosis with eosinophil infiltration that indicated by yellow arrows. (b) Edema of Purkinje fiber. (c) Fragmentation with mild myocardial necrosis

receptors and thereby increases cAMP concentration. This blockade can free cholinergic neurons from inhibitory control, leading to pervasive excitatory responses; studies with rat brain indicate that sodium- and chloride-dependent taurine transporters exist in the blood–brain barrier. The activity of these transporters is tightly regulated by transcription of the genes encoding them. This transcription seems to be dependent on the degree of cell damage, osmolality, and taurine in the brain, suggesting that active expression of this gene is an acute response to neuronal crisis.^[9,17]

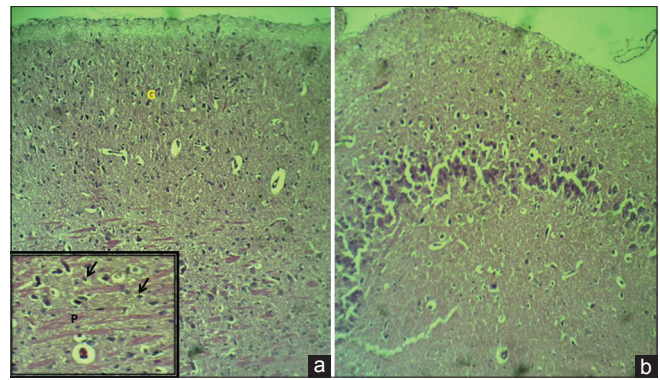


Figure 8: Photomicrograph of the brain in low dose-treated group show (a) cerebral cortex showing shrunken, pyknotic and darkly stained with small nuclei neurons (arrows), aggregation of focal eosinophilic plaques (P), and focal gliosis (G). (b) Hippocampus show slightly decreasing the number of neuronal cells, (H and E, $\times 100$, $\times 100$)

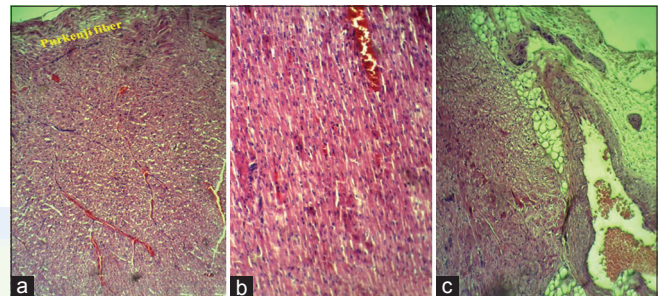


Figure 10: Photomicrograph of heart in control group showing (a) normal histological structures of the endocardium and Purkinje fiber. (b) Normal myocardial structures. (c) Epicardium or visceral pericardium has the normal appearance (H and E, $\times 100$)

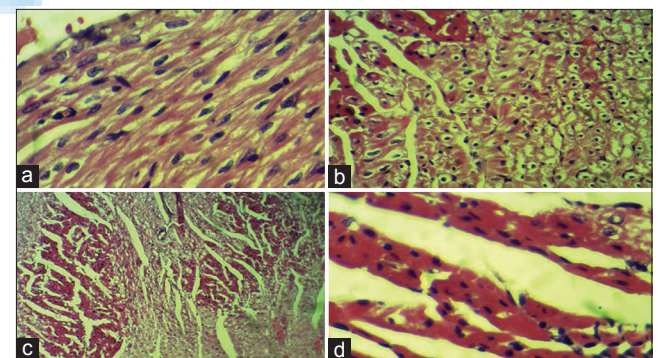


Figure 12: Photomicrograph of heart in high dose-treated group show (a) edema of Purkinje fibers show enlarged with rectangular nuclei. (b) Moderate muscle necrosis; small dark pyknotic nuclei and hyper eosinophilia, coagulation, and clamping of the sarcoplasm. (c) The arrangement of myofibers is disrupted by edematous fluid, and the darker red myocytes are necrotic. (d) Higher magnification of section c - note the myocardial fiber degeneration and necrosis with loss of cross striations and fragmentation of cardiac rhabdomyocytes

By this experiment to explore the effect of red bull on main critical organs such as kidney, liver, heart, and brain, we can conclude that energy drinks have dose–response

relationship with adverse effect; it has become apparent that the consumption of these energy drinks will seriously harm the body.^[18] From our study we conclude that energy drinks have many harmful side effect due to the presence of many ingredients, while the side effects of each ingredient are not serious enough to be banned by the Food and Drug Administration.^[19,20]

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Nil.

Conflicts of interest

There are no conflicts of interest.

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