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The Impact of Energy Drinks on Liver Health

Nadia F. Ismail [1], Ghada Hamdy [2], Ayman A. Hassan [2], Alaa Elmetwalli [2,3*], Mohamed Salah [4], Jihan Hassan [5]

[1] Health information management program, Biochemistry, Faculty of Health Sciences Technology, Borg El Arab Technological University, Alexandria, Egypt..; [2]Higher Technological Institute of Applied Health Sciences, Egyptian Liver Research Institute and Hospital (ELRIAH), Sherbin, Mansoura, Egypt.; [3]Department of Clinical Trial Research Unit and Drug Discovery, Egyptian Liver Research Institute and Hospital (ELRIAH), Mansoura, Egypt.; [4]Tropical Medicine Department, Mansoura University, Mansoura, Egypt.; [5]Department of Applied Medical Chemistry, Medical Research Institute, Alexandria University, Alexandria, Egypt

Abstract

Background: Energy drinks (EDs) have become a mainstay for many people looking for a quick energy boost thanks to their enormous rise in popularity in recent years. However, several studies have brought attention to the possible negative health consequences linked to the intake of these drinks. **Objective:** This study aimed to look into the impact of EDs on liver biochemical, liver histology, and glucose levels as well. **Materials and methods:** Three groups of rats were placed: control group, red bull group, and power horse group, each receiving a regular diet and daily red bull energy drink. liver, kidney, glucose, and insulin were evaluated. Further, histological examination was evaluated. **Results:** ALT and AST blood levels were significantly higher in the energy drink groups compared to the control group. There were no significant differences in AST and ALT levels between the energy drink groups. Serum creatinine levels were also significantly higher in the energy drink groups compared to the control group, with no significant difference between the energy drink groups. Random blood sugar levels were significantly higher in the energy drink groups compared to the control group, with no significant differences between the energy drink groups. Insulin levels were significantly higher in the power horse group compared to both the red bull and control groups, but there was no significant change between the control and red bull groups. Additionally, liver damage was confirmed by biopsy in patients who had ingested EDs. **Conclusion:** The use of EDs like red bull and power horse has been shown to have serious adverse effects on the liver. Consequently, it is important to be aware of the potential health risks associated with consuming these energy drinks.

Introduction

Energy drinks (EDs) are recognized as non-alcoholic drinks with significant caffeine content [1]. Caffeine is the principal active component in energy drinks, along with taurine, guarana, glucuronolactone, B vitamins, and ginseng. Red bull and power horse are two examples of energy drinks available on the market [2]. According to advertisements, these energy drinks may increase strength, endurance, and alertness, and treat hangover symptoms. In Egypt, red bull is the most widely used EDs [3]. The stimulant-like chemicals included in EDs are not on the FDA's (Food and Drug Administration) list of substances subject to regulation in the United States. Varied kinds of EDs include varied amounts of these stimulants, and in most instances, these levels are greater than those that are permitted [4]. Caffeine, a methylxanthine, is widely recognized for stimulating the central nervous system (CNS), which helps with cognitive functions, improved alertness, and postponed weariness. Chronic daily headaches, anxiety, insomnia, increased urination, arrhythmia, and stomach distress are all linked to high caffeine use of more than 400 mg per day [5].

Guarana, a component of energy drinks, is an extract from the seeds of the *Paullinia cupana Mart var Sorbilis plant*. It contains four times as much caffeine as coffee beans. The amino acid 2-aminoethane-sulfonic acid, or taurine, is widely distributed in human tissue, particularly the liver [6]. Energy drinks have become a mainstay for many people looking for a quick energy boost thanks to their enormous rise in popularity in recent years. However, several studies have brought attention to the possible negative health consequences linked to the intake of these drinks [7]. While energy drinks could provide you a short-term energy boost, it's important to think about the possible negative health implications of using them. Numerous health risks associated with energy drink use include elevated heart rate and blood pressure, irregular sleep patterns, dehydration, electrolyte imbalances, gastrointestinal disorders, and dental troubles [8]. When contemplating the intake of alcoholic drinks, it is essential to use moderation and give priority to one's general health and well-being [9]. We designed this research to examine the harmful effects of extended EDs consumption on body weight, and hepatic, and renal function tests due to the aforementioned factor.

Materials and methods

Energy drinks source and ingredients

Red Bull was bought in cans (250 ml) at an on-site grocery in Alex. Red Bull has the following ingredients in each 100 ml serving: taurine (400 mg), sucrose and glucose

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* Corresponding author. email: dr.prof2011@gmail.com

(11.3 g), B1 (0.4 mcg), caffeine $C8H10N4O2$ (32 mg), gluconolactone (240 mg), niacin (7.2 mg), B6 mg, panthenol (2.4 mg), inositol (20 mg), B2 (0.64 mg), artificial flavoring, and sparkling water.

Power Horse energy drinks GmbH, an Austrian company, is responsible for making power horse energy drink. The nutritional information for each 100 ml of power horse energy drink is as follows: 45 kcal, (32 mg) of caffeine, (0.4 g) of taurine, (10.7 g) of carbs, (0.06 g) of riboflavin (B2), (8 mg) of niacin (B3), (2 mg) of pantothenic acid (B5), and (2 mg) of pyridoxine (B6); no fat, fibre, or protein are included.

Animals:

In accordance with the Medical Research Institute, Alexandria University's guidelines for animal care and use (IACUC), this approval has been granted. IACUC has approved this protocol with approval number (IACUC-AU-012-23-8-6-3-2). All procedures were performed according to the ARRIVE guidelines to ensure the best possible care was given to the animals during the research. 24 mature female albino Sprague Dawley rats, weighing an average of 125.5 g, were utilized in the study. The animals came from Pharos University in Alexandria's animal home of medicine and pharmaceutical manufacture. Each rat was kept in a unique cage under carefully monitored conditions. The animals were scrutinized every day for their outward look, shape, hair distribution, and physical activity. Before the trial, all rats received a 3-day supply of the control food. Each rat was weighed individually before the experiment began and again eight weeks afterwards. To prevent food loss, the diet was given to the rats in specially covered cups. Water was given to all rats via wire cages and glass tubes [10].

Animal experimental design:

Eight rats were placed in each of the three groups of animals. Control group: Rats in that group received a regular normal diet. Red Bull group: Rats in this group received a regular baseline diet along with 5 ml/100 g of the energy drink Red Bull every day for two months. Power horse group, in which rats received a regular baseline diet along with 5 ml/100 g of the energy drink power horse every day for two months.

Determination of changes in body weight and dietary intake:

At the start of the trial, all of the rats were weighed. According to Chapman et al. [11], the biological effectiveness of the various diets was assessed after the experiment by measuring body weight gain percentage (BWG%).

Blood collection and plasma preparation:

By puncturing the heart, plasma was extracted from the entire blood of sacrificed rats and placed in heparin-filled tubes. The plasma was then centrifuged at 1000 g for 10 min at 25°C, and the tubes containing the obtained plasma were then placed at -20°C until further analysis [12].

Biochemical investigations:

According to the manufacturer's instructions, Spectrum UV kinetic technique kits (Spectrum, USA) were used to assess the activities of ALT and AST [13] calorimetrically, as well as the levels of creatinine (Cr), random blood sugar (RBS), and Insulin levels were determined as described previously respectively [14, 15].

Histological examination

To detect any histological abnormalities, liver tissues were washed with xylene, fixed in paraffin wax, segmented at a thickness of 5 mm, and stained with eosin and hematoxylin. Concentrations of ethanol were used as a desiccant in this process [16].

Results

Effect of EDs on body weight changes in different rat groups

The mean body weight in control and various treatment groups was revealed in **Table 1**. In the experimental red ball-treated group compared to the control group, it was discovered that the mean body weight decreased considerably. Comparing the Red ball and power horse group to the control group, there is no discernible difference. These two groups demonstrated a noteworthy increase in body weight against the baseline body weight. However, compared to controls, the weights in both groups were dissimilar and a good response in the control group rather than the other groups.

Effect of EDs on liver and kidney functions in different rat groups.

A significant increase in ALT and AST blood levels was observed when energy drinks were compared to controls. Further, no significant differences were observed between ED groups as regarding the AST and ALT. The serum creatinine (Cr) levels were also significantly higher in the ED groups compared to the control group with no significant difference between ED groups **Figure 1.**

Effect of EDs on glucose and insulin concentration in different rat groups

The levels of glucose and insulin in the rat groups were shown in **Figure 2.** The EDs groups had a significantly higher random blood sugar (RBS) than the control group, with no significant differences observed between the ED groups. As for insulin levels, there was a significant increase in the bower horse group compared to both the red bull and control groups. However, there was no significant change when comparing the control and red bull groups.

Histopathology examination

The liver of the control group may be seen in the photomicrograph with normal hepatic architecture, including the central vein (CV), the portal region (P), polyhedral-shaped hepatocytes (arrow), and blood sinusoids (arrowhead). HandE with bar=50 m (Figure 3A). A photomicrograph of the liver from the red bull group revealed a swollen CV, a little enlargement of the blood sinusoids (black arrowhead), a slight degradation of the hepatocytes (arrows), and a slight activation of the Kupffer cells (white arrowheads). HandE; bar = 50 m (Figure 3B). The photomicrograph depicts the liver of the power horse group revealing the presence of tiny focal areas and diffuse pleomorphic darkly basophilic cells, indicated by arrows, in the perivascular region surrounding the congested CV. Additionally, moderate congestion of some blood sinusoids, denoted by arrowheads, Bar=50 µm **Figure 3C**.

Table 1. Effect of EDs on body weight changes in different rat groups

Animal groups		Control	Red Bull group	Power horse group
Mean		178.3^{a}	142.6^{b}	138.4^{b}
±SE		±0.41	±0.57	±0.32
% of change	*		-0.36	-24.50
	**			**-27.13**

In each group, results are expressed by means ± SE. Similar letters show the marked change at P ≤ 0.05. similar letters showing (non-significant) and the significance is expressed by dissimilar letters. (*) & (**) = % of change compared to control and other groups respectively.

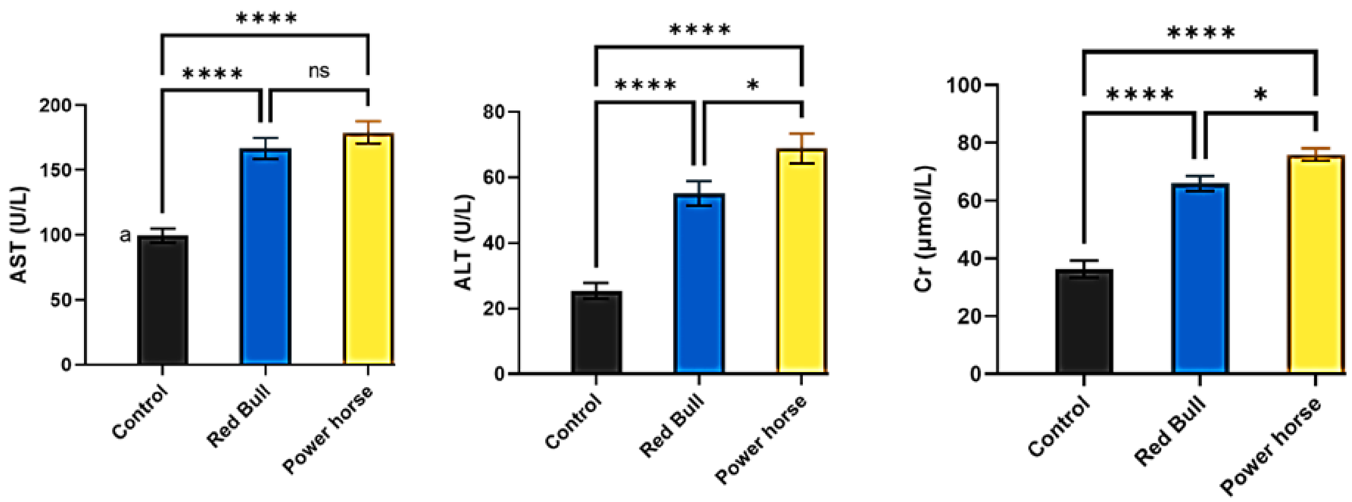

Figure 1: Effect of EDs on AST, ALT, and Cr in different rat groups. ns; non-significant, *P; <0.01, ****P; <0.0001.

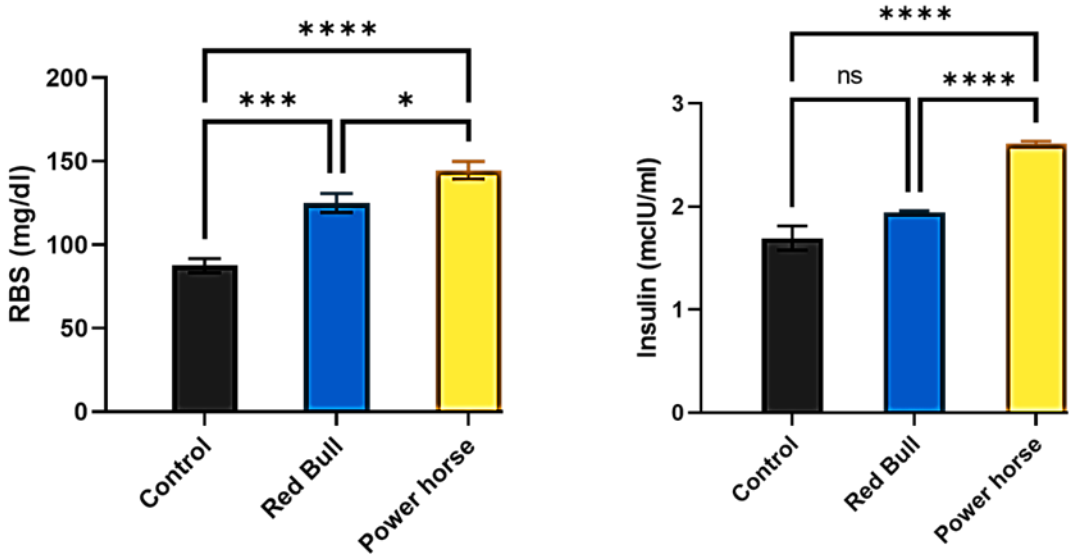

Figure 2: Outcome of EDs on RBS and insulin in different rat groups. ns; non-significant, *P; <0.01, ****P; <0.0001.

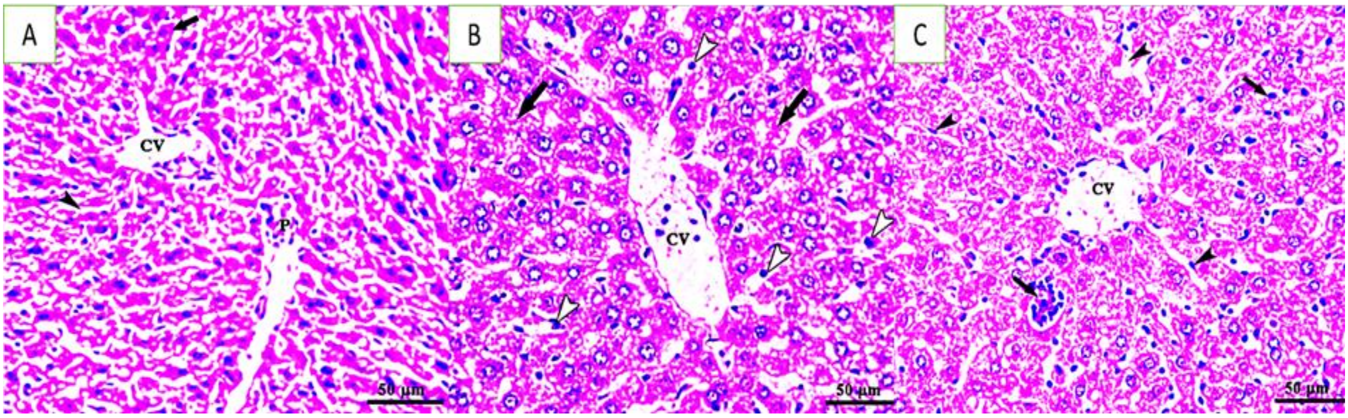

Figure 3. (A) The liver of the control group may be seen in the photomicrograph with normal hepatic architecture, including CV. (B) The photomicrograph of the liver from the Red bull group revealed a swollen CV and a little enlargement of the blood sinusoids. (C) The photomicrograph depicts the liver of the power horse group revealing the presence of tiny focal areas and diffuse pleomorphic darkly basophilic cells. Scale Bar=50 µm

Discussion

The use of EDs has seen a significant surge in Egypt over the last few years, accompanied by a diverse range of brands and tastes that are readily accessible on the market [17]. These beverages are promoted as a means to enhance energy levels and enhance cognitive abilities, rendering them widely favored among student populations, athletes, and those in professional settings. EDs contain ergogenic substances (caffeine, taurine) that make them more stamina or energy. Each individual has a different tolerance for the content of EDs [18]. Therefore, this study aimed to figure out the impact of EDs (Red Bull and Power horse) on liver physiology and glucose physiology.

In the first place, in a state of optimal bodily health, surplus compounds included in energy supplements undergo first processing inside the liver before being eliminated from the body through urine, sweat, or faecal matter. The inclusion of stimulant components, such as taurine and caffeine, in energy supplements imposes an increased burden on the liver's functioning [19].

The onset of direct toxicity can lead to fatality within a few hours, whereas the toxic effects resulting from long-term accumulation manifest gradually by inducing liver damage [20]. Various factors, such as chronic alcohol consumption, viral infections, and prolonged usage of specific medications, can contribute to impairment of liver function [21]. In the current study, our data revealed that the liver enzymes ALT and AST were increased 2 fold at least as compared to the control group. This could be explained by the fact that there is a growing prevalence of liver injury among individuals due to their addiction to EDs [22]. For instance, a single unit of EDs includes a quantity of niacin that is comparable to 40 mg. The use of an excessive amount of niacin is associated with liver damage, as indicated by the LD50 limit of niacin at 50 mg/kg body weight [23]. The body's need for niacin is determined by the Nutrition Adequacy Rate (RDA), which suggests a daily intake of 14 mg for adult women and 16 mg for adult males [24].

Furthermore, EDs often include varying amounts of carbs, namely glucose and fructose, ranging from 0 to 67 g/240 ml of the beverage. Based on the established standards set out by the British Food Standard Agency (FSA), EDs of this kind are classified as food and beverage products that contain a considerable amount of sugar [25]. This category often encompasses food and drinks that possess a sugar content above 10 g/100 g of product [26]. The top-selling energy beverage on the market is composed of 14 g of sugar per 100 ml of liquid, resulting in an equivalent of six to seven teaspoons of sugar for a standard 250 ml. Based on this fact, our study has concurred with this issue as the levels of insulin and glucose were increased than the control group [27]. Consequently, it can be inferred that an average energy drink typically has a quantity of sugar equivalent to around 13 teaspoons, which is slightly more than a quarter cup. The FDA does not provide a specific daily recommended amount for sugar consumption. Nevertheless, it is worth noting that the official standards in the United States advocate for a maximum sugar consumption of 32 g per 2000 calories, or roughly 7% to 8% of the overall daily caloric intake [28]. Specifically, the intake of sugary beverages is linked with several health issues, including obesity, dental caries, type II diabetes, and cardiovascular illnesses [29].

Conclusion

This study shows that energy drinks like Red Bull and Power Horse can have harmful effects on liver function. Histological analysis of liver tissue has also revealed potential health risks associated with consuming these beverages.

Conflict of interest: the authors declared that there is no conflict of interest.

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