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Acute administration of Red Bull affects blood parameters in untrained and trained young males

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SUMMARY. The worldwide consumption of energy drinks has grown globally during the last few decades among athletes and youth, because of their stimulant properties. Although these beverages are consumed in order to improve concentration, physical and cognitive performance, there is insufficient evidence or studies to confirm these claims. The aim of our study was to investigate if acute administration of Red Bull energy drink influences certain biochemical parameters of the blood as well as blood pressure and heart rate, under physical activity in trained and untrained healthy males.

Thirteen healthy voluntary males between the ages 20-25 years participated in this study. They were organized in two groups: trained and untrained. Blood samples were drawn and certain hemodynamic parameters were measured before and after physical activity/Red Bull administration. Anthropometrical measurements were also determined.

A significant increase of blood pressure and heart rate were noticed after Red Bull administration in all subjects, while the glucose concentration decreased. The concentration of total protein increased significantly after Red Bull administration, as did the activities of serum LDH, AST and ALT. These results indicate that acute consumption of energy drinks can affect biochemical blood parameters as well as the hemodynamic parameters.

Keywords: blood, caffeine, energy drinks, Red Bull

Introduction

The worldwide consumption of energy drinks has grown globally during the last few decades amoung athletes and youth, because of their stimulant properties (Kumar *et al.,* 2015). The investigations conducted among athletes showed that energy drinks are frequently consumed by athletes prior to competitions in order to improve their performance (Astorino *et al.,* 2011; Desbrow and Leveritt, 2007).

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Alford *et al.* (2001) reported that consumption of energy drinks delay the onset of exhaustion. The stimulating properties of Red Bull stem from the combined action of its ingredients: caffeine, taurine, carbohydrates (glucose and sucrose), B3 vitamin, glucuronolactone etc. Usually, energy drinks contain high amounts of carbohydrates along with nutrients purposed to improve self-perceptions of attention and/or mental alertness. Low calorie energy drinks are also marketed to increase mental alertness, energy metabolism, and performance (Cambell *et al*., 2014). These ingredients taken separately should increase athletic performance.

Caffeine is a potentially useful ergogenic resource for the short loading period after weigh in (Lopez-Silva *et al*., 2014). It has been found that athletes use caffeine before competitions, a discovery made via urine testing during doping checks (Del Coso *et al*., 2012). The ingestion of caffeine increases mental performance (Da Silva *et al*., 2015) and in combination with carbohydrates before and during a badminton match can maintain serve accuracy, anticipation timing and sprinting actions around the court (Clarke *et al*., 2015). It also produces mild central nervous system stimulation, similar to that of amphetamines, reducing fatigue and increasing concentration and alertness. Physiological effects include increased heart rate and output, metabolic rate and urine production (Avois *et al*., 2006). Reisenhuber *et al.* (2006) showed that caffeine in energy drinks has diuretic and natriuretic effects. High doses can cause anxiety, insomnia, and nervousness. In 2004, caffeine was removed from the list of prohibited substances and is now part of the monitoring programme (Avois *et al*., 2006).

There is clear evidence in literature that a normal taurine level is important for the normal functioning of skeletal muscle. Its main roles are to facilitate Ca^{2+}-dependent excitation-contraction coupling, to contribute to the regulation of cellular volume, and to help in antioxidant defense from stress responses (Spriet *et al*., 2015). Taurine, which is an aminosulphonic acid, reduces oxidative stress during exercise and also acts as an antihypertensive agent (Luckose *et al*., 2015). El Idrissi *et al.* (2014) mentioned that acute administration of taurine may be beneficial to lowering blood pressure.

Niacin is important for maintenance of cellular integrity and energy production and is involved in a lot of intracellular reactions. It has been shown that niacin has positive effects on all cardiovascular events on atherosclerosis evolution (Julius, 2010). Ringseis *et al.* (2013) showed that the niacin-induced changes in skeletal muscle phenotype are indicative of an increased capacity of skeletal muscle for oxidative utilization of fatty acids.

The long term effects of energy drinks consumption as well as short term effects are controversial. Shearer *et al.* (2014), reported two opposing effects of caffeine and caffeine-containing energy drinks, their positive effects on athletic performance and their negative impacts on glucose tolerance in the sedentary state. Negative effects of energy drinks affect especially physiological and behavioral moods (Jackson

et al., 2013). An increasing number of problems with behavior modification and cognitive capabilities in adolescents who use energy drinks have been reported (Van Battenburg-Eddes *et al*., 2013). Positive effects of energy drinks were mentioned in a few studies. According to Duncan and Hankey (2013), beneficial effects of energy drinks were observed on perception of extertion, leg muscle pain perception and readiness to invest effort during submaximal cycling in active adults. Peacock *et al*. (2013) demonstrated that long term consumption has positive effect on performance, reducing the reaction time.

Short term negative effects of energy drinks have also been proven. Acute ingestion of Red Bull increases the heart rate and both diastolic and systolic blood pressure, but it does not cause alteration in ventricular repolarization (Elitok *et al.,* 2015; Marczinski *et al.,* 2014; Grasser *et al.,* 2014; Grasser *et al.,* 2015). On the other hand, there are researches that showed positive effects such as soft improvements in physical endurance and mental performance, including concentration and memory (Alford *et al*., 2001; Scholey and Kennedy, 2004). Moreover, Menci *et al.* (2013) showed that the acute consumption of energy drinks causes a significant increase of right and left ventricular myocardial function.

Further knowledge about the effects of energy drink consumption on health is very important, especially given its prevalence among young people and athletes. Therefore, the aim of our study was to investigate whether acute administration of an energy drink, Red Bull, affects certain biochemical parameters of the blood as well as blood pressure and heart rate, while performing intense physical activity (sport exercises) in physically fit and unfit young males, henceforth referred to trained (T) and untrained (U).

Materials and methods

Participants. Thirteen healthy voluntary males between the ages of 20-25 years were selected to participate in this study. They were organized in two groups: trained (T) and untrained (U). The trained volunteers were rugby players of Rugby Team of the Babes-Bolyai University of Cluj-Napoca. The untrained volunteers were young college students who self-reportedly do not engage in regular demanding physical activity. All participants were informed about the purpose and demands of the study before giving their written consent to participate. All volunteers were self-declared as healthy, with no history of cardiovascular, urinary, digestive or metabolic diseases (determined by questionnaire). The protocol was in accordance with the *Declaration of Helsinki* (http://sites.jamanetwork.com/declaration-of-helsinki/index.html, 1964) for research on human subjects. Table 1 shows the main characteristics of participants in this study.

Experimental design. All subjects were instructed not to consume food, energy drinks, coffee and alcohol 12 h prior to the onset of the experiment. In the first day anthropometrical measurements were recorded. Blood samples were drawn and blood preassure and heart rate were measured twice, once before and once after performing physical exercises. Following a warm-up the participants were asked to undergo Astrand Cycle Ergometer Test for five minutes. One day later, the protocol was repeated, however after the initial recordings and blood sampling, the subjects ingested one dose of Red Bull. A period of 45 minutes of rest followed, after which the warm-up and Astrand test were perfomed.

Assays. Blood was collected from the antecubital forearm vein and processed for biochemical examinations at Medstar Laboratory from Cluj-Napoca, Romania. A Conelab.30i determined glycemia, proteinemia, LDH, AST and ALT activities.

Data analysis. The results are presented as mean ± standard error (SE). The data were analyzed for statistical significance using unpaired Student's *t* test. A value of $p < 0.05$ was considered significant.

Table 1.

Comparison of anthropometric data between trained (n=6) and untrained (n=7) subjects

	TRAINED	UNTRAINED
WEIGHT (kg)	102.4±2.7	77.74±4.85
HEIGHT (m)	1.83±0.03	1.83±0.03
BMI (kg/m^2)	30.66±1.06	23.15±1.30
BF %	19.2±1.6	42.54±1.43
Bm %	41.16±1.02	13.32±1.78

BMI-body mass index; Bm%-percent of body muscle; BF%-percent of body fat. Data are mean±standard error.

Results and discussion

The aim of our study was to investigate if acute administration of Red Bull energy drink influences some biochemical parameters of the blood as well as blood pressure and heart rate, under intense physical activity in trained and untrained males.

As expected, physical activity increased the systolic pressure in both groups (Table 2). The results of this study confirm the literature data, according to which physical activity increases sistolic pressure (Marczinski *et al.,* 2014). However, physical activity decreased diastolic pressure, contrary to previous studies in the literature which reported that effort in fact increases diastolic pressure (Elitok *et al.,* 2015; Grasser *et al.,* 2014; Grasser *et al.,* 2015). Furthermore, Red Bull has been shown to increase even more the systolic pressure in both groups and to restore

diastolic pressure to both subject categories. Restoration of diastolic pressure may be due to caffeine, which has diuretic and natriuretic effects (Reisenhuber *et al.,* 2006) and causes peripheral vasoconstriction (Knight *et al.,* 2015), which is followed by tachycardia (heart rate increase) (Higuchi *et al.,* 2015).

The results of this study indicate that the heart rate increases during physical activity (Table 2), an increase which is intensified by the energy drink consumption, more specifically by the caffeine it contains (Steinke *et al.,* 2009; Marczinsky *et al.,* 2014; Elitok *et al.,* 2015).

Table 2.

Effects of exercise and Red Bull on hemodynamic and biochemical blood parameters

	TRAINED			UNTRAINED		
Parameter	RT	T	TRB	RU	U	URB
HR (beats/min)	74.71±4.6	167±7.98	172.28±6.1	68.83±4.49	163±4.37	171.66±6.4
SBP (mmHg)	129±6.37	153.33±8.13	176.66±9.88	117.14±4.34	142.25±8.85	135±5.45
DBP (mmHg)	77.33±3.07	74.16±2.38	78.33±2.78	72.14±2.14	67.14±1.84	72.14±2.14
Glycaemia (mg/dl)	94.5±1.89	91.5±1.78	73.66±7.45*	85.28±3.12	90.28±5.45	85.57±5.09
Proteinemia (g/dl)	7.19±0.13	7.85±0.09**	7.64±0.15	7.11±0.08	8.01±0.15***	8.01±0.10***
LDH activity (U/l)	165±7.58	187.8±4.39	194.8±7.85	136.28±7.85	157.57±11.50	174.14±5.87
ALT activity (U/l)	24.8±1.39	26.6±1.50	27.25±1.28	17±2.98	18.85±3.58	20.14±2.91
AST activity (U/l)	21.2±3.30	21.8±3.59	24.2±1.31	18.71±1.56	19.28±2.21	25±5.77

RB-Red Bull; HR-heart rate; SBP-sistolic blood pressure; DBP-diastolic blood pressure; RT-resting trained group; T-trained group after exercises; TRB-trained group after exercises and Red Bull administration; RU-resting untrained group; U-untrained group after exercises; URB-untrained group after exercises and Red Bull administration. The results are expressed as mean±SE.
Glycaemia *$p < 0.05$ *vs* exercises
Proteinemia **$p < 0.01$ and ***$p < 0.001$ *vs* resting

Physical activity did not produce significant changes in glucose blood concentration (Table 2, Fig. 1 a). However, Red Bull was observed to have determined a significant decrease of glycaemia in trained males. These results are in accordance with the results of Phillips *et al.* (2014). It is possible that the results in this study were influenced by the niacin in Red Bull, which intensified the use of glucose as a cofactor for the enzymes that are involved in the glycolytic pathway. The amount of niacin found in one dose of Red Bull is slightly higher than daily recommended dose.

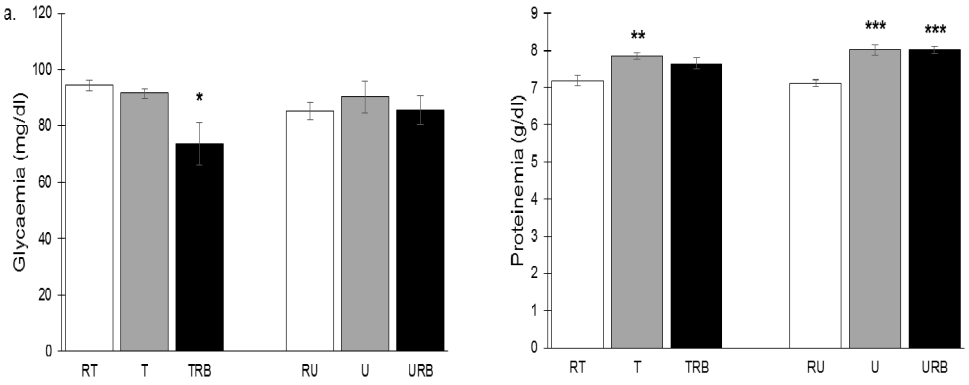

Figure 1. Changes in glycaemia (*p < 0.05 *vs* exercises) (a) and proteinemia (**p < 0.01 and ***p < 0.001 *vs* resting) (b) after exercises and Red Bull administration in the two experimental groups. n=6 in trained group and n=7 in untrained group. RT-resting trained group; T-trained group after exercises; TRB-trained group after exercises and Red Bull administration; RU-resting untrained group; U-untrained group after exercises; URB-untrained group after exercises and Red Bull administration. The results are expressed as mean±SE.

The question is why the same effect was not observed in untrained subjects. It is well known that physical activity increases insulin sensitivity by activating the AMP-activated protein kinase (AMPK) in the skeletal muscle and adipose tissue, which translocates the GLUT-4 to the membrane and facilitates the glucose uptake (O'Neill, 2013). In theory, the consequence would be that the glycaemia would drop following physical activity and Red Bull consumption in both groups, trained and untrained. In this study, we can only assume that the trained muscle is more sensitive to insulin and more responsive to glycaemia increase.

The proteinemia increased significantly in both groups after physical activity coupled with Red Bull administration (Table 2, Fig. 2 b). The increase of protein concentration may be due to muscle damage that occurs during intense effort and this subject matter requires further investigations.

The activities of LDH and ALT increased after physical activity. Red Bull intensified this increase in both groups (Table 2, Fig. 2 a and b). In the case of LDH activity, the increase may be due to the high amount of caffeine which stimulates LDH activity to sustain the lactate production (Dias *et al*., 2015).

ALT and AST activities increase due to muscle injury (Hazar *et al*. 2014). In trained subjects the increase of ALT activity may be due to the release of enzymes from both the liver and skeletal muscles following physical activity (Hazar *et al*., 2014). Red Bull consumption is believed to have increased the serum ALT activity even further (Table 2, Fig. 2 b). At this moment, the mechanism behind this reaction is unclear.

As depicted in Table 2 and Fig. 2 c, AST activity was not affected by physical activity, but rather increased after Red Bull administration. Similarly, Hazar *et al.* (2011) did not find any difference in the AST value after exercise in their study, which was carried out with professional sportsmen. As with ALT activity, the mechanism behind AST activity increase following Red Bull consumption is unclear.

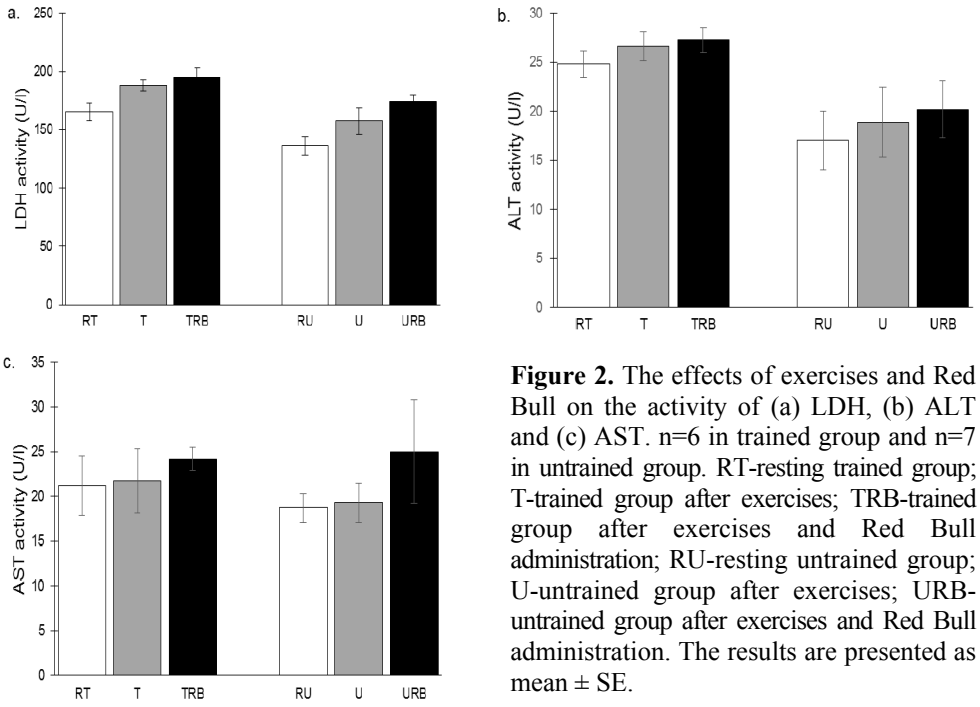

Figure 2. The effects of exercises and Red Bull on the activity of (a) LDH, (b) ALT and (c) AST. n=6 in trained group and n=7 in untrained group. RT-resting trained group; T-trained group after exercises; TRB-trained group after exercises and Red Bull administration; RU-resting untrained group; U-untrained group after exercises; URB-untrained group after exercises and Red Bull administration. The results are presented as mean ± SE.

Conclusions

The results of the present study indicate that energy drinks such as Red Bull can affect biochemical blood parameters, as well as blood pressure and heart rate. Furthermore, energy drinks may be a risk factor for the development of cardiovascular diseases. Further research is required, while raising awareness among young people and athletes about the potential acute effects of energy drink consumption is important.

REFERENCES

Alford, C., Cox, H., Wescott, R. (2001) The effects of Red Bull energy drink on human performance and mood, *Amino Acids,* **2**, 139-150

Astorino, T. A., Martera, A. J., Basinger, J., Evans, M., Schurman, T., Marquez, R. (2012) Effects of red bull energy drink on repeated sprint performance in women athletes *Amino Acids,* **5**, 1803-8

Avois, L., Robinson, N., Saudon, C., Baume, N., Mangin, P., Saugy, M. (2007) Central nervous system stimulants and sport practice, *Br. J. Sports Med.,* 16-20

Cambell, B., Wilborn, C., La Bounty, P., Taylor, L., Nelson, N. T., Greenwood, M., Zeingenfuss, T. N., Lopez, H. L., Hoffman, J. R., Jeffrey, R. S., Schmitz, S., Collins, R., Kalman, D. S., Antonio, J., Kreider, R. B. (2013) International Society of Sports Nutrition position stand: energy drinks*, J. Int. Soc. Sports Nutr.,* **10**, 1

Clarke, N. D., Dunca, M. J. (2015) Effects of carbohydrate and caffeine ingestion on badminton performance, *Int. J. Sports Physiol. Perform.,* (epub ahead of print)

Da Silva, V. L., Messias, F. R., Zanchi, N. E., Gerlinger-Romero, F., Duncan, M. V., Guimaraes-Ferreira, L. (2015) Effects of acute caffeine ingestion on resistance training performance and perceptual responses during repeated sets to failure, *J. Sports Med. Phys. Fitness,* **5**, 383-9

Del Coso, J., Salinero, J. J., Gonzales-Millan, C., Vicen-Abian, J., Perez-Gonzales, B. (2012) Dose response effects of a caffeine-containing energy drink on muscle performance: a repeated measures design, *J. Int. Soc. Sports Nutr.,* **1**, 9-21

Desbrow, B., Leveritt, M. (2007) Well-trained endurance athletes knowledge, insight and experience of caffeine use, *Int. J. Sport Nutr. Exerc. Metab.,* **4**, 328-39

Dias, T. R., Alves, M. G., Bernardino, R. L., Martins, A. D., Horeira, A. C., Silva, J., Barros, A., Sousa, M., Silva, M., Oliveira, P. F. (2015) Dose-dependent effects of caffeine in human Sertoli cells metabolism and oxidative profil: relevance for male fertility, *Toxicology,* **328**, 12-20

Duncan, M. J., Hankey, J. (2013) The effect of a caffeinated energy drinks on various psychological measures during submaximal submaximal cycling, *Physiol. Behav.,* **5**, 116-117

Elitok, A., Oz, F., Panc, C., Jarikaya, R., Sezikli, S., Pala, Y., Bugan, O. S., Ates, M., Parildar, H., Ayaz, M. B., Atici, A., Oflaz, H. (2015) Acute effects of Red Bull energy drink on ventricular repolarization in healthy young volunteers: a prospective study, *Anatol. J. Cardiol.,* **15** (epub ahead of print)

El Idrissi, A., Okeke, E., Yan, Y., Sidime, F., Neuwirth, L. S. (2013) Taurine regulation of bloos pressure and vasoactivity, *Adv. Exp. Med. Biol.,* **777**, 407-25

Grasser, E. K., Yepuri, G., Dullo, A. G., Montani, J. P. (2014) Cardiovascular and cerebrovascular responses to the energy drink Red Bull in young adults: a randomized cross-over study, *Eur. J. Nutr.,* **7**, 1761-71

Grasser, E. K., Dullo, A. G., Montani, J. P. (2015) Cardiovascular and cerebrovascular effect in response to Red Bull consumption with mental stress, *Am. J. Cardiol.,* **2**, 183-9

Hazar, M., Otag, A., Otag, I., Sezen, M., Server, O. (2014) Effect of increasing maximal aerobic exercise on serum musles enzymes in professional field hockey players, *Glob. J. Health Sci.,* **3**, 69-74

Higuchi, H., Yabuki, A., Ishii-Maruhama, M., Tomoyasu, Y., Maeda, S., Myawaki, T. (2015) Hemodynamic changes by drug interaction of Adrenaline with chlorpromazine, *Anesteh. Prog.,* **4**, 150-4

Kumar, J., Park, S., Onufrak, S. (2015) Perceptions about energy drinks are associated with energy drinks intake among U.S. youth, *Am. J. Health Promot.,* **4**, 238-44

Jackson, D. A., Cotter, B. V., Merchant, R. C., Babu, K. M., Baird, J. R., Nirenberg, T., Linakis, J. G. (2013) Behavioral and physiologic adverse effects in adolescents and young adult emergency department patients reporting use of energy drinks and caffeine, *Clin. Toxicol.,* **7**, 557-65

Julius, U. (2015) Niacin as antidyslipidemic drug, *Can. J. Physiol. Pharmacol.,* **28**, 1-12

Knight, R., Pagkalos, J., Timmons, C., Jose, R. (2015) Caffeine consumption does not have an effect on digital microvascular perfusion assessed by laser Doppler imaging on healthy volunteers: a pilot study, *J. Hand. Surg. Eur.,* **4**, 412-4

Luckose, F., Pandey, M. C., RadhaKrishna, K. (2015) Effects of amin oacid derivatives on physical, mental and physiological activities, *Crit. rev. Food Sci. Nutr.,* **13**, 1793-807

Marczinski, C. A., Stamates, A. L., Ossege, J., Maloney, S. F., Bardgett, M. E., Brown, C. J. (2014) Subjective state, blood pressure, and behavioral control changes produced by an „Energy Shot", *J. Caffeine Res.,* **2**, 57-63

Menci, D., Righini, F. M., Cameli, M., Lisi, M., Benincasa, S., Focardi, M., Mondillo, S. (2013) Acute effects on an energy drink on myocardial function assessed by conventional echo-Doppler analysis and speckle tracking echocardiography on young healthy subjects, *J. Amino Acids,* 2013, 1-7

O´Neill, O. M. (2013) AMPk and exercise: glucose uptake and insulin sensitivity, *Diabetes Metab. J.,* **37**, 1-21

Peacock, A., Martin, F. H., Carr, A. (2013) Energy drinks ingredients. Contribution of caffeine and taurine to performance outcomes, *Appetite,* **64**, 1-4

Phillips, M. D., Rola, K. S., Christen, K. V., Ross, J. W., Mitchel, J. B. (2014) Preexercise energy drinks consumption does not improve endurance cycling performance but increases lactate, monocyte and interleukine-6 response, *J. Strengh Cond. Res.,* **5**, 1443-53

Reisenhuber, A., Boehm, M., Posch, M., Aufricht, C. (2006) Diuretic potential of energy drinks, *Amino Acids,* **1**, 81-3

Ringseis, R., Rosenbaum, S., Gessner, D. K., Herges, L., Kubens, J. F., Mooren, F. C., Kruger, K., Eder, K. (2013) Supplementing obese Zucker rats with niacin induces the transition of glycolitic to oxidative skeletal muscle fibers, *J. Nutr.,* **2**, 125-31

Scholey, A. B., Kennedy, D. O. (2004) Cognitive and physiological effects of an energy drink: an evaluation of the whole drink and of glucose, caffeine and herbal flavouring fractions, *Psychopharmacology,* **3-4**, 320-30

Shearer, J., Graham, T. E. (2014) Performance effects and metabolic consequences of caffeine and caffeinated energy drinks consumption on glucose disposal, *Nutr. Rev.,* **1**, 121-36

Spriet, L. L., Whitfield, J. (2015) Taurine and skeletal muscle function, *Curr. Opin. Clin. Nutr. Metab. Care,* **1**, 96-101

Steinke, L., Lanfear, D. E., Dhanapal, V., Kalus, J. S. (2009) Effects of „energy drinks" consumption on hemodynamic and electrocardiographic parameters in healthy young adults, *Pharmacother.,* **4**, 596-602

Van Battenburg-Eddes, T., Jolles, J. (2013) How does emotional relate to underachievement in a general population sample young adolescents: a neurocognitive perspective, *Front. Psychol.,* **4**, 673

*** "Declaration of Helsinki History Website". Ethical Principles For Medical Research. The JAMA Network