

Knowledge and behavior of Saudi University athletes toward energy and sport drinks with emphasis on microbial quality and safety

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Summary. The aim of this study was to assess the knowledge and behavior of university athletes in Saudi Arabia toward energy and sports drinks. Also, the microbiological quality of local drinks available in the market was also assessed. Of the 120 university athletes surveyed, 69 were taking sports drinks, whereas 51 were taking energy drinks. The study consisted of ten questions related to the university athletes' sociodemographic characteristics, personal habits, sports and energy drinks related knowledge, and habits. For the question related to the main reason for using energy drinks, results showed that 50.98% ($n=26$) believed that energy was the main reason for using energy drinks. On the other hand, 36.23% ($n=25$) believed recovery from injury or illnesses was the main reason for consumption of sports drinks. A majority of university athletes ($n=43$, 62.32%) who used SDs said they thought SDs were safe to use while $n=22$ (43.14%) were unaware of the safety of EDs. Total bacterial coliform, count, *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus* were included in this analysis. Of the total of 26 tested sports and energy drinks, microbial contamination was present in only two products. Microbial levels and the total bacterial count for most of the samples were very low (<1 log CFU/ml). However, some drinks had a slightly higher microbial level which could be harmful or cause spoilage when improperly stored. Thus, our findings suggest that improvements are needed in these sports and energy drinks.

Key words: sports drinks (SDs), energy drinks (EDs), knowledge, behavior, microbial quality, safety, University athletes

Introduction

The consumption of Sports Drinks (SDs) and Energy Drinks (EDs) has become a popular practice worldwide, especially among athletes. SDs and EDs are being marketed to athletes for a wide variety of inappropriate uses (1). SDs and EDs are significantly different products, and the terms should not be used interchangeably. These drinks represent a large and growing beverage industry now marketed to athletes. Marketing strategies for sports drinks recommend optimization of athletic performance and replacement of fluid and electrolytes lost in sweat during and after exercise, an increase in en-

ergy, decreased fatigue, enhanced focus, enhanced tolerance for additional training, enhanced ability to cope with pain, providing energy (speed, strength, power), and mental alertness (2). However, sports drinks are different products than energy drinks. Sports drinks are flavored beverages that contain carbohydrates, minerals (sodium, potassium, calcium, and magnesium), electrolytes, and sometimes vitamins (vitamin B12, vitamin B6, vitamin B6) or other dietary supplements. Although the term "energy" can be perceived to imply calories, energy drinks typically contain stimulants such as caffeine and taurine, guarana, and varying amounts of carbohydrates, proteins, vitamins, and other minerals (3). The Saudi

government has decided to ban ED advertising altogether. This ban also applies to the distribution of free energy drinks to users of all ages and forbids the sale of energy drinks in eating place and cafeterias in facilities, education and health facilities, halls of control, and private sports clubs (4). A committed Council of Ministers of Saudi Arabia of factory owners and importers of energy drinks has warned of the harmful effects of products. The Gulf Cooperation Council states are signing an agreement no later than 2017 on doubling the tax on EDs (5, 6). As the worldwide market for energy drinks approaches nearly \$15 trillion, the general consumption of EDs has increased accordingly, particularly among Youth, adolescents, and university students. The consumption rates among this demographic are growing because of the concentration enhancement and fatigue-relieving effects of energy drinks (7-9), yet there is relatively little information about the safety and quality of these products. Furthermore, information on the use of energy drinks among students is unclear and misleading. In the pursuit to be the strongest and the fastest, many youths, adolescents, and students consume unverified, potentially harmful, or even banned energy drinks. General EDs such as Red Bull, Power Horse, Bison, Bugzy, Code Red, Boom Boom, Shark, Double Horse, Black, and AMP were used in this study (4, 8, 10). However, SDs such as Powerade, Gatorade, Vitamin water, Sobe Lifewater, Revive, and All Sport have a specifically limited function for athletes. These drinks would be ingested when there is a need for more rapid replacement of electrolytes in combination with water during episodes of a prolonged vigorous sports participation and intense physical activity (11, 12). Caffeine is no longer banned by the WADA (World Anti-Doping Agency). However, one would only use caffeine with the guidance of a sports scientist or sports dietitian, and single responses to caffeine should be used with care. Red Bull energy drink is a common carbonated taurine, sugar, and caffeine that claims to "vitalize the body and mind."

The use of Red Bull energy drink is supported by a fair amount of scientific research and endorsed by recognized sports professionals (12-16). There are many ways to evaluate the microbiological quality and safety of commercial energy drinks available in local stores, and tests need to be conducted to ensure their micro-

biological quality. However, overdosing can negatively affect reaction time and alertness (11, 17-19). However, there has been no research regarding the quality and safety of these products in Saudi Arabian markets.

To our knowledge, there is very limited published information related to the consumption of energy and sports drinks among Saudi university athletes and microbial quality and safety. Therefore, the current study was conducted to explore the intake and attitudes of athletes toward energy drinks and the microbial quality and safety of these drinks available in the Saudi market.

Method

The survey of university athletes consisted of male students from Riyadh in Saudi Arabia; the questionnaires were designed to help the researcher understand the university athletes' use and perceptions of SDs and EDs. Two groups of questionnaires were established for this survey and results were compared and analyzed to determine the use of SDs and EDs.

Sampling and survey questionnaires

One hundred twenty university athletes were recruited as subjects from the most popular university students. All participants were checked randomly and were either Saudis or foreign nationals. A survey had been developed to conduct the data for each of the study's objectives. The questionnaire consisted of ten questions divided into different categories, including the reason for consumption, personal beliefs, knowledge, behavior, and safety. The review questions pertained to the frequency of SD and ED purchases as well as factors that might be considered by university athletes when purchasing these products.

Data collection and statistical analysis

It took approximately three months to administer the surveys and collect the data from the participants. During the months of January and March 2016, the survey was given to each athlete. The time and location for each survey were arranged and announced at least two weeks in advance. Approximately ten minutes were needed to distribute the surveys and provide

information, while it took about 25 minutes for participants to complete the survey questionnaires. The Statistical Analysis System (SAS, Inc., Cary, NC, USA) was used to evaluate the statistics for this study. The dependent variable attitudes were measured by directing the questionnaire that contained ten questions divided into different categories, including the reason for consumption, personal beliefs, knowledge, behavior, and safety. The independent variables were the university athletes' responses. Consequences were analyzed using chi-square tests with a significance level of 0.05.

Sampling for quality and safety of drinks

Twenty-six different commercial SDs and EDs were collected from local stores in Riyadh, Saudi Arabia. These products were randomly labeled with a unique identification number. For example, three digits represented the day of month and time (110 means the first day of the month at 10 am). All products were chosen in duplicate from each store and then shipped to the Laboratory of Food Microbiology at NC A&T State University in Greensboro, NC for microbial quality and product safety analysis.

Microbial analysis

From each commercial sample, 25 ml were placed in 100 ml sterilized BHI broth and mixed carefully. Samples were then incubated at 37°C for 4 h to allow for microbial cell recovery, if present. One milliliter of the individual sample was then withdrawn and diluted with 0.1% peptone water. The appropriate dilutions were plated onto identical selective agar plates. To obtain the total number of bacterial count, samples were plated on Brain Heart Infusion Agar (BHI Agar). To test for the Coliform Bacteria and *Escherichia coli*, samples were plated on *Violet Red Bile Glucose Agar* (VRGBA) and *MacConkey agar*, respectively. Likewise, samples were plated on *Xylose Lysine Desoxycholate Agar* (XLD) for *Salmonella Agar*, and *Baird-Parker Agar Base* (BPAB) for *Staphylococcus aureus* count.

Results

This study focused on the knowledge and behavior of Saudi university athletes toward SDs and EDs

with an emphasis on microbial quality and safety. Table 1 shows the number of university athletes by age that participated in the survey. Of the total of 120 participants in the survey, $n=11$ (9.2%) were 18 years of age or younger, $n=96$ (80.0%) were 19–23 years of age and $n=13$ (10.8%) were 24 years of age or older. The number of university athletes from King Saud University (male) was 120, which includes freshmen ($n=11$; 9.2%), sophomores ($n=41$; 34.2%), juniors ($n=26$; 21.7%), seniors ($n=35$; 29.2%), and graduated university athletes ($n=7$; 5.8%). The survey contained 10 questions concerning frequency of knowledge and behavior of Saudi university athletes toward SDs and EDs with an emphasis on microbial quality and safety. University athletes involved in this study took SDs and EDs. Of the 120 university athletes surveyed, $n=69$ (57.50%) were currently taking sports drinks, and $n=51$ (42.50%) were currently taking energy drinks (mean age and standard deviation were 21.43 ± 1.77). Therefore, we focused only on those 120 university athletes who were consuming SDs and EDs.

Table 2 shows the responses of athletes' knowledge and attitudes towards SDs and EDs. In the first question, we asked the overall impression and attitude toward these products. Of university athletes using SDs, $n=41$ (59.42%) had a positive response towards

Table 1. Participant demographics ($N=120$)

Demographic Characteristic	n (%)
Age	
18 or younger	11 (9.2)
19-23	96 (80.0)
24 or older	13 (10.8)
University level	
Freshman	11 (9.2)
Sophomore	41 (34.2)
Junior	26 (21.7)
Senior	35 (29.2)
Graduated	7 (5.8)
SD and ED consumption	
Using SDs	69 (57.50)
Using EDs	51 (42.50)

Note. The results showed the response does differ significantly ($p<0.0001$) from the hypothesized value (0.05) announce demographic data was limited to age, and university level.

SDs, $n=18$ (26.09%) had a negative response, and $n=10$ (14.49%) were neutral about the impression of these products. Similarly, of University athletes using EDs, $n=29$ (56.86%) thought positively of EDs, $n=13$ (25.49%) felt negative about EDs, and $n=9$ (17.65%) were neutral about the impression of EDs. In the second question relating to the frequency of consumption of SDs among university athletes, the results showed a high percentage of university athletes ($n=32$; 46.38%) use SDs daily, followed by $n=20$ (28.99%) weekly, $n=12$ (17.25%) monthly, and $n=5$ (7.25%) rarely. Of university athletes using EDs, $n=19$ (37.25%) use EDs daily, $n=16$ (31.37%) use EDs weekly, $n=11$ (21.57%) use EDs monthly, and $n=5$ (9.80%) use EDs rarely.

In the question concerning the main reason for using EDs and SDs, results showed that university athletes use these products for different reasons. For example, of university athletes who use EDs, $n=26$ (50.98%) believed that energy boost (speed, strength, power) was the main reason for using EDs, followed by $n=13$ (25.49%) for recovery from an injury or illness, $n=6$ (11.76%) for enhanced tolerance for additional training, and $n=2$ (3.92%) each for enhanced ability to cope with pain and improved endurance. However, of university athletes using SDs, $n=25$ (36.23%) reported using SDs for recovery from an injury or illness, followed by $n=18$ (26.09%) for providing energy (speed, strength, power), $n=9$ (13.04%) for enhanced ability to cope with pain, $n=8$ (11.59%) for improved endurance, and $n=5$ (7.25%) for enhanced tolerance for additional training.

A majority of university athletes who use SDs ($n=27$; 39.13%) think SDs are used as a dietary supplement, followed by $n=22$ (31.88%) who had no information, $n=19$ (27.54%) thought SDs are used to boost energy, and $n=1$ (1.45%) thinks SDs work as stimulants. Similarly, for university athletes who use EDs, $n=23$ (45.10%) thought EDs boost energy, $n=14$ (27.45%) do not have any information, $n=12$ (23.53%) thought EDs work as a dietary supplement, and $n=2$ (3.92%) considered EDs as stimulants.

Of university athletes using SDs, most ($n=19$; 27.54%) received SD information from family members or friends, followed by $n=16$ (23.19%) from retail stores. However, less than 10% of university athletes using SDs reported their sources of information from each category of nutritionist or dietician, online, and

Table 2. Knowledge and attitudes towards SDs ($n=69$) and EDs ($n=51$) among university athletes

Response	SDs <i>n</i> (%)	EDs <i>n</i> (%)
1. What is your overall impression and attitude toward these products?		
Positive	41 (59.42)	29 (56.86)
Negative	18 (26.09)	13 (25.49)
Neutral	10 (14.49)	9 (17.65)
2. How often do you consume these products?		
Every day	32 (46.38)	19 (37.25)
Once per week	20 (28.99)	16 (31.37)
Once per month	12 (17.25)	11 (21.57)
Rarely	5 (7.25)	5 (9.80)
3. What is the main reason for consuming these products? (Most important reason)		
Provide energy (speed, strength, power)	18 (26.09)	26 (50.98)
Recover from an injury or illness	25 (36.23)	13 (25.49)
Improve endurance	8 (11.59)	2 (3.92)
Enhance tolerance for additional training	5 (7.25)	6 (11.76)
Enhance ability to cope with pain	9 (13.04)	2 (3.92)
Other	4 (5.80)	2 (3.92)
4. What are these products used for?		
Elements to boost energy	19 (27.54)	23 (45.10)
As a dietary supplement	27 (39.13)	12 (23.53)
As stimulants	1 (1.45)	2 (3.92)
Do not know	22 (31.88)	14 (27.45)
5. How do you obtain information about these products?		
Coach or physician	14 (20.29)	4 (7.84)
Nutritionist or dietician	8 (11.59)	5 (9.80)
Family or friends	19 (27.54)	21 (41.18)
Online	7 (10.14)	4 (7.84)
Retail store	16 (23.19)	8 (15.69)
Others	5 (7.25)	9 (17.65)

Note. The results showed the response does differ significantly ($p < 0.0001$) from the hypothesized value (0.05) indicating knowledge and attitudes towards S.D and E.D differ from each individual.

other sources. Furthermore, most university athletes using EDs ($n=21$; 41.18%) received information about EDs from family members or friends; however, less than 10% of university athletes using EDs reported

their sources of information about EDs from each category of retail store, nutritionist or dietician, online, coach or physician, and other sources.

Table 3 lists responses to Questions 6–8 related to the athletes' perceptions of the safety of drinks. Of the 69 university athletes using SDs, $n=38$ (55.07%) agreed that SDs have no associated side effects, whereas $n=22$ (31.88%) did not know about product side effects and $n=9$ (13.04%) believed that there are side effects associated with these products. On the other hand, a majority of university athletes using EDs ($n=21$; 41.18%) agreed that EDs have no associated side effects, and $n=17$ (33.33%) thought these products are safe to consume. Only $n=13$ (25.49%) of the 51 university athletes who used EDs had no information about these products.

A majority of university athletes who use SDs ($n=41$; 59.42%) agreed that sports drinks had no effect on the immune system, whereas $n=13$ (18.84%) believed that SDs had an effect on the immune system. Of the 69 university athletes who use SDs, $n=15$ (21.74%) did not have any information related to the effects of SDs on their immune system. On the other hand, a majority of university athletes who use EDs ($n=22$; 43.14%) thought EDs had no effect on the immune system, followed by $n=17$ (33.33%) who had no information about the potential risk of EDs on the immune system. A large number of university athletes who use SDs ($n=43$; 62.32%) agreed that SDs are safe to consume, whereas $n=15$ (21.74%) had no clue about product safety. Of the 69 athletes who use SDs, $n=11$ (15.94%) believed SDs are not safe to consume. On the other hand, $n=22$ university athletes (43.14%) who use EDs had no information regarding the safety of EDs, followed by $n=18$ (35.29%) who thought that these products are safe to consume. Only $n=11$ (21.57%) of the 51 university athletes who use EDs believed EDs are not safe to consume.

Table 4 lists the SDs that university athletes reported using during the session in our study. We were interested in knowing more about the types of SDs that were being used among these athletes. These athletes reported using more than seven different products most frequently. Our results showed that Gatorade consumption ($n=34$; 49.28%) was the highest among all these drinks followed by Powerade,

Table 3. Safety of SDs ($n=69$) and EDs ($n=51$) among university athletes

Response	SDs n (%)	EDs n (%)
6. Do you identify if there are any side effects of these products?		
Yes	9 (13.04)	17 (33.33)
No	38 (55.07)	21 (41.18)
Do not know	22 (31.88)	13 (25.49)
7. Should you worry about these products' effects on your immune system?		
Yes	13 (18.84)	12 (23.53)
No	41 (59.42)	22 (43.14)
Do not know	15 (21.74)	17 (33.33)
8. Do you consider these products safe to use?		
Yes	43 (62.32)	18 (35.29)
No	11 (15.94)	11 (21.57)
Do not know	15 (21.74)	22 (43.14)

Note. The results have shown the response does differ significantly ($p<0.0001$) from the hypothesized value (0.05) indicating reasons for safe to use these products differ from each individual.

Sobe Lifewater, All Sport, Vitamin water, and Re-
vive. Consumption of SDs not listed here represent $n=11$ athletes (15.94%).

Table 5 lists the EDs that university athletes reported during the session in this survey questionnaire. We were interested in knowing more about the

Table 4. Type of SDs and frequency of use among university athletes ($n=69$)

Category of SDs	n	%
9. Which of these sports drinks have you used most frequently?		
Powerade	7	10.14
Gatorade	34	49.28
Vitamin water	4	5.80
Sobe Lifewater	6	8.70
Revive	3	4.35
All Sport	4	5.80
Other	11	15.94

Note. The results have shown the p -value is 0.0001, we can conclude that there is the statistically significant difference between the type of sports drinks and frequency of use among university athletes.

types of energy drinks that were being used among these university athletes. University athletes reported using more than 12 different products. Our results showed that Red Bull ($n=20$; 39.22%) and Code Red ($n=13$; 25.49%) were the most popular EDs, followed by Bugzy ($n=4$; 7.84%), Vault ($n=3$; 5.88%), and Power Horse, Black, Boom Boom, and AMP ($n=2$; 3.92%).

Table 6 shows 26 different commercial drinks including EDs ($n=20$; 76.92%) and SDs ($n=6$; 23.08%) that were collected from local stores in Riyadh and their caffeine levels, pH values, and total bacterial counts. The results showed that none of the commercial samples contain harmful pathogens. The results indicated the absence of *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus*. The total plate count of bacteria for most of the samples was very low ($<1 \log \text{CFU/ml}$). Only two tested samples had a bacterial population of approximately 2.00 Log CFU/ml. These samples had low caffeine concentrations and higher pH values compared to other samples. In addition, microbial populations in six different sports drinks were below a detectable level.

Table 5. Type of EDs and frequency of use among university athletes ($n=51$)

Category of EDs	n	%
10. Which of these Products have you used most frequently?		
Red Bull	20	39.22
Code Red	13	25.49
Bison	2	3.92
Bugzy	4	7.84
Power Horse	2	3.92
Vault	3	5.88
Blu Day	1	1.96
Black	2	3.92
Boom Boom	2	3.92
Shark	0	0.00
AMP (simply Amp)	2	3.92
Other	0	0.00

Note. The results have shown the p -value is 0.0001, we can conclude that there is the statistically significant difference between the type of energy drinks and frequency of use among university athletes

Discussion

In this study, we conducted a survey concerning the consumption of SDs and EDs among university athletes ($N=120$) with an emphasis on microbial quality and safety of these products. Based on these results, university athletes most commonly appeared to have a lack of knowledge about popular SDs and EDs. Because university athletes are typically under much pressure to perform well, some are always in need of SDs and EDs to enhance performance. Since doping is illegal, these university athletes need legal nutritional

Table 6. List of sports and energy drinks, quantity of caffeine¹ total bacterial count and pH values

Product number	Caffeine (mg/L)	Total Bacterial Count (Log CFU/mL)	pH value
1	3500	1.60	3.85
2	300	<1.0	4.10
3	280	<1.0	3.00
4	530	1.20	86.00
5	300	<1.0	3.90
6	900	<1.0	4.10
7	320	1.70	3.54
8	210	<1.0	4.15
9	450	<1.0	4.23
10	500	<1.0	3.90
11	120	2.10	3.79
12	310	1.30	3.75
13	500	<1.0	3.80
14	310	1.75	4.05
15	400	<1.0	3.76
16	500	<1.0	3.95
17	160	2.30	4.20
18	50	2.5	4.10
19	10	2.1	3.87
20	290	<1.0	2.70
21	0	<1.0	2.70
22	0	<1.0	4.00
23	0	<1.0	5.60
24	0	<1.0	3.60
25	0	<1.0	5.40
26	0	<1.0	3.75

¹ Cola has 100 and coffee ~ 250mg/1L

² <1.0 (CFU/ml) means below detectable level

guidelines. There is little-published data regarding the consumption of SDs and EDs in Saudi Arabia; thus, there is an inherent need to improve knowledge of SD and ED use among athletes. Each year, new SDs and EDs appear in growing Saudi Arabia markets, and intake of SDs and EDs among university athletes is also increasing (20). Some research studies in the past have shown a positive correlation between the nutrition knowledge of college students and the quality of their energy drink intake (21). This finding is similar to other similar studies conducted on SD and ED consumption patterns of college students in the U.S., and college students in Manila (21-23).

Of the 120 university athletes surveyed about SDs and EDs, we found that $n=69$ (57.50%) were currently taking SDs and $n=51$ (42.50%) were taking EDs. Survey results showed that a majority of university athletes use these products throughout the year either to improve and enhance performance or only to improve their health. In earlier studies (21), it has been noted that EDs among college students is primarily used to improve and enhance performance. Likewise, in a study involving Saudi students, 73% of the students reported using energy drinks (17).

In our current study, the results showed that of university athletes who use SDs, $n=32$ (46.38%) use sports drinks daily, whereas of university athletes who use EDs, $n=19$ (37.25%) use EDs daily (23) also reported that college students consume EDs at least 2-5 days per week. Similarly, results also showed that 40% of students drink EDs at least once a week and are likely to increase the frequency of drinking to twice a week (34%). On the other hand, professionals reported the frequency of drinking EDs at least once a week (36%) with the likeliness of increased intake to more than three times a week (21). Similarly, in another study, it was delineated that 18.8% of young adults consumed energy drinks at least weekly (24). Also, the average amount of energy drink consumption among nursing students after studying for examinations was 1.63 ± 2.64 cans or bottles per week, and the number of energy drink cans or bottles drunk during that time spanned 1-30 per week (25).

Regarding the main reason for using EDs and SDs, results from the current study showed that university athletes use these products for different reasons.

For example, $n=26$ university athletes (50.98%) using EDs believed gaining speed, strength, and power as the main reason for using EDs. However, of the university athletes using SDs, $n=25$ (36.23%) reported using SDs for recovery from an injury or illnesses. Similarly, in Reid et al.'s (26) study, energy drinks were used most commonly to enhance energy (50%), combat sleepiness (45%), improve and enhance academic performance (40%), and enhance performance during sports (23%). In another study by Bawazeer and AlSobahi (27), it was found that the main reason for energy drink consumption among college students was studying for exams or finishing a project (31.4%).

Our results showed that a majority of university athletes who use SDs ($n=43$; 62.32%) agreed that SDs are safe to consume, whereas $n=15$ (21.74%) had no information about product safety. Of the 69 athletes who used SDs, $n=11$ (15.94%) did not consider SDs safe to use. On the other hand, a majority of athletes using EDs ($n=22$; 43.14%) had no information regarding the safety of EDs followed by $n=18$ (35.29%) who thought these products were safe to consume. The only $n=11$ of the 51 athletes using EDs (21.57%) believed these products are not safe. In a previous study, Bawazeer and AlSobahi (27) found the main reason to use the energy drinks was to increase the energy in general (32.8%); other reasons sleep deprivation (12.8%), as friends (11.4%), or driving (8.5%). In another study, it was found that the main reason for consuming energy drink among college students was working overtime to finish a course project or working overtime at the office (21). In another study, taste athletes (31%) endorsed pleasurable taste, energy-seeking athletes (24%) endorsed function and taste motives, and hedonistic athletes (33%) endorsed pleasure and sensation-seeking motives (28). In a study by Kim and Kim (25), additional reasons for energy drink consumption was for enhanced recovery (79.9%), concentration (29.3%), and curiosity (22.0%).

A study by Emond, Sargent, and Gilbert-Diamond (29) showed that athletes received most of their information about energy drinks from stores, college students, friends, and manufacturers that primarily advertise on television and social media. These results were similar to our study's results, where most university athletes who use SDs ($n=19$; 27.54%) reported a

family member or friend as their main source of information on these products, followed by retail stores ($n=16$; 23.19%), coach or physician ($n=14$; 20.29%), nutritionist or dietician ($n=8$; 11.59%), and online ($n=7$; 10.14%). Also, most university athletes using EDs ($n=21$; 41.18%) reported a family and friend as their main source of information on these products. However, less than 10% of university athletes using EDs reported their sources of information from each category of nutritionist or dietician, online, and other sources.

In the present study, university athletes using EDs reported using more than 12 different products most frequently. Our results showed that Red Bull ($n=20$; 39.22%) and Code Red ($n=13$; 25.49%) were the most popular EDs, followed by Bugzy ($n=4$; 7.84%), Vault ($n=3$; 5.88%), and Power Horse, Black, and Boom Boom, each at $n=2$ (3.92%). Similarly, Barcelona et al. (21) also reported Cobra, Red Bull, and Monster Energy as the most popular products used by students. These authors reported that among the popular brands of drinks, Cobra was significantly more popular among professionals (58%), while Red Bull and Monster were more popular among students.

Since this survey was conducted among Saudi university athletes, it may not reflect university athletes' worldwide characteristics. Nonetheless, this investigation into the factors that affect ED and SD consumption behaviors is significant because it sheds light on the regulations concerning the related markets of EDs and SDs and accurate knowledge of the side effects; thus, they restricted the sale and use of EDs in universities, schools, and even café shops (5).

Conclusions and Future Directions

Many university athletes consume sport and energy drinks as a part of their daily routines. These products are often used without university athletes having a full understanding of the potential benefits, negative effects, and risks associated with their use without consultation with sports nutrition professionals. More research and increased public awareness are needed to bring about an improvement in the education of athletes in the area of SDs and EDs. This education must

highlight the difference between SDs and EDs and their associated potential health risks. In this study, we also evaluated the microbiological quality and safety of 26 of the most common EDs and SDs available in local stores in Saudi Arabia. The samples were selected based on the size of the samples and affordability to purchase the products. Our results confirm the safety and quality of all tested products as they showed low levels of total bacterial population and the absence of pathogenic bacteria. Regarding consumption of SDs and EDs by athletes we should:

- Improve the education of athletes in the area of sports and energy drinks. This education must highlight the difference between SDs and EDs and their associated potential health risks.
- Be aware that these products could pose potential health risks primarily because of their stimulant content; therefore, they are not appropriate for athletes and should never be consumed.
- Counsel athletes whose routine ingestion of carbohydrate-containing SDs should be avoided or restricted.
- Educate athletes for whom sports drinks have a specifically limited function for athletes. These drinks should be ingested when there is a need for more rapid replenishment of carbohydrates in combination with water during sports participation or other intense physical activity.
- Promote water, not SDs or EDs, as the principal source of hydration for athletes.
- Conduct more research related to the microbial content and quality of not only SDs and EDs but also other popular sports supplements that are currently being sold in the Saudi markets.

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References

- Aljaloud, S. O. (2013). Understanding the behavior and attitude of professional athletes in Saudi Arabia toward dietary supplements (Doctoral dissertation, North Carolina Agricultural and Technical State University).
- Aljaloud, S. O., & Ibrahim, S. A. (2013). Use of dietary supplements among professional athletes in Saudi Arabia. *Journal of Nutrition and Metabolism*, 2013, 245349. doi:10.1155/2013/245349
- Schneider, M. B., & Benjamin, H. J. (2011). Sports drinks and energy drinks for children and adolescents: Are they appropriate? *Pediatrics*, 127(6), 1182–1189.
- Aljaloud, S. O. (2016a). Use of energy drinks among college students in Saudi Arabia. *American Journal of Sports Science*, 4(3), 49–54.
- Aljaloud, S. O. (2015). Dietary supplements for professional athletes: A great potential for Saudi Arabia. *Journal of Nutritional Health & Food Engineering*, 3(1), 00097. doi:10.15406/jnhfe.2015.03.00097
- Aljaloud, S. O. (2016b). Microbiological quality and safety of energy drink available in the local markets in Saudi Arabia. *International Journal of Food Science, Nutrition and Dietetics*, 5(4), 287–289. doi:10.19070/2326-3350-1600051
- Center, E. C. W. S., Education, D., Center, F. C., Miles, O. T., & Miles, P. T. (2006). Energy and sports drinks. *Texas Cooperative Extension*. Vol. 10 No. 2
- Kim, Y. J., Jeon, E. M., Shim, S. B., & Seo, H. J. (2015). Effects of awareness and knowledge of energy drinks on consumption patterns among college students. *Korean Journal of Health Promotion*, 15(1), 31–38.
- Temple, J. L., Ziegler, A. M., & Epstein, L. H. (2016). Influence of price and labeling on energy drink purchasing in an experimental convenience store. *Journal of Nutrition Education and Behavior*, 48(1), 54.
- Spierer, D. K., Blanding, N., & Santella, A. (2014). Energy drink consumption and associated health behaviors among university students in an urban setting. *Journal of Community Health*, 39(1), 132–138.
- Navarro-Pascual-Ahuir, M., Lerma-García, M. J., Simó-Alfonso, E. F., & Herrero-Martínez, J. M. (2016). Determination of water-soluble vitamins in energy and sport drinks by micellar electrokinetic capillary chromatography. *Food Control*, 63, 110–116.
- Alhyas, L., El Kashef, A., & AlGhaferi, H. (2016). Energy drinks in the Gulf Cooperation Council states: A review. *JRSM Open*, 7(1), 2054270415593717.
- Alrasheedi, A. A. (2016). Prevalence and reasons for consumption of energy drinks among adolescents and young adults in Jeddah, Saudi Arabia. *Global Journal of Health Science*, 9(2), 23.
- Ayuob, N., & ElBeshbeishy, R. (2016). Impact of an energy drink on the structure of stomach and pancreas of albino rat: Can Omega-3 provide a protection? *PloS one*, 11(2), 0149191.
- Doherty, M., & Smith, P. (2005). Effects of caffeine ingestion on rating of perceived exertion during and after exercise: A meta analysis. *Scandinavian Journal of Medicine & Science in Sports*, 15(2), 69–78.
- Magkos, F., & Kavouras, S. A. (2004). Caffeine and ephedrine: Physiological, metabolic and performance-enhancing effects. *Sports Medicine*, 34(13), 871–889.
- Aljaloud, S. O., Ibrahim, S. A., Fraser, A. M., Song, T., & Shahbazi, A. (2013). Microbiological quality and safety of dietary supplements sold in Saudi Arabia. *Omega*, 3, 32.
- Clauson, K. A., Shields, K. M., McQueen, C. E., & Persad, N. (2008). Safety issues associated with commercially available energy drinks. *Pharmacy Today*, 14(5), 52–64.
- Sather, T. E., & Delorey, D. R. (2016). Energy beverage consumption among naval aviation candidates. *Aerospace medicine and human performance*, 87(6), 557–564.
- Aljaloud S. O. (2014). Availability of dietary supplements in Saudi Arabia. *Journal of Theories and Applications the International Edition, Alexandria – Egypt*, 82(2), 86–100.
- Barcelona, E., Capule, A. B., Cruz, J. F., Macam, F., & Robles, R. (2014). A survey on the intake of energy drinks among college students and young professionals in Metro Manila. *Asian Journal of Agriculture and Food Sciences*, 2(6), 554–559. Retrieved from <http://www.ajouronline.com/index.php?journal=AJAFS&page=article&op=view&path%5B%5D=1920&path%5B%5D=1103>
- Lieberman, H., Marriott, B., Judelson, D., Glickman, E., Geiselman, P., Giles, G., & Mahoney, C. (2015). Intake of caffeine from all sources including energy drinks and reasons for use in US college students. *The FASEB Journal*, 29(1 Suppl. 392-1).
- Trunzo, J. J., Samter, W., Morse, C., McClure, K., Kohn, C., Volkman, J. E., & O'Brien, K. (2014). College students' use of energy drinks, social problem-solving, and academic performance. *Journal of Psychoactive Drugs*, 46(5), 396–401.
- Larson, N., Laska, M. N., Story, M., & Neumark-Sztainer, D. (2015). Sports and energy drink consumption are linked to health-risk behaviours among young adults. *Public Health Nutrition*, 18(15), 2794–2803. doi:10.1017/S1368980015000191
- Kim, I. K., & Kim, K. M. (2015). Energy drink consumption patterns and associated factors among nursing students: A descriptive survey study. *Journal of Addictions Nursing*, 26(1), 24–31.
- Reid, S. D., Ramsarran, J., Brathwaite, R., Lyman, S., Baker, A., D'Andra, C. C., & Thapelo, C. K. (2015). Energy drink usage among university students in a Caribbean country: Patterns of use and adverse effects. *Journal of Epidemiology and Global Health*, 5(2), 103–116.
- Bawazeer, N. A., & AlSobahi, N. A. (2013). Prevalence and side effects of energy drink consumption among medical students at Umm Al-Qura University, Saudi Arabia. *International Journal of Medical Students*, 1(3), 104–108. Retrieved from <http://www.ijms.info/archives/v01/i03/a02/v01i03a02.pdf>
- Dillon, P., Svikis, D., Pomm, D., Thacker, L., Kendler, K., & Dick, D. (2015). Understanding the buzz about energy

- drink use in college students. *Drug & Alcohol Dependence*, 146, e267.
29. Emond, J. A., Sargent, J. D., & Gilbert-Diamond, D. (2015). Patterns of energy drink advertising over US television networks. *Journal of Nutrition Education and Behavior*, 47(2), 120–126.

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