A Can of Bull? Do Energy Drinks Really Provide a Source of Energy?

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This case study involves the biochemical analysis of the components of commonly available energy drinks, which many students purchase at fairly high prices. Students research the ingredients in each product and their physiological role in the human body, and then attempt to match what they learn with the product manufacturers’ marketing claims. The case can be used as a review of basic biochemistry and nutrition for upper level students in physiology, biochemistry, or nutrition courses—or to introduce this information in basic courses in these disciplines.

The case

After spending several years working the sports’ desk of the Lansing State Journal, Rhonda had landed the job of her dreams as a writer for Runners’ World magazine. The job was fantastic! Since high school, where she had excelled in cross country, Rhonda had been a consistent runner, participating in local races and now those assigned to her for work. For her last Runner’s World assignment, she had run and reported on a Leadwood, South Dakota, marathon—it was a blast!

As if reading her mind, her boss Charley walked in just then with a can of XS Citrus Blast in one hand and a list of several other energy drinks in the other.

“We’ve been getting a lot of inquiries about the different energy drinks on the market, including XS Citrus Blast. Do you know anything about them?” Charley asked.

“I know that people use them for various reasons,” replied Rhonda. “It seems they’re primarily used by athletes to provide some ‘fuel’ as they practice and compete. Other people use them more casually as a way to become ‘energized.’ That’s about all I know.”

“That seems to be about all any of us knows,” Charley said.

“For your next assignment,” Charley continued, “I want you to find out what each of the ingredients in these drinks is and what it does for a runner or for a nonathlete. You need to be very accurate in your analysis—determine what each component really does for the body, not what the marketers want you to believe it does. Then look at the marketing claims of some of these drinks and see if the scientific facts match up to them. Many of our readers are using these drinks with a some general notion that they’re helpful, but they’re basing their use of them on no scientific information. I’ve got the marketing claims (Figure 1), a short list of questions that should get you started (Figure 2), and a list of ingredients and nutrition facts provided on the cans for consumers (Figure 3, page 42). When you research these, be sure to document all your sources, keeping in mind that all resources are not equal. Here’s the material.”

With that, Charley left the office. Rhonda looked over the lists.

“Guess I’ll have to brush up on my biochemistry. No problem. I’m interested in knowing if my running
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Case scenario, in which students read about a writer at *Runner’s World* magazine who has been assigned the task of evaluating the usefulness of a selection of energy drinks.

Marketing claims for each of the energy drinks under review, which include Citrus Blast, Red Bull Energy Drink, Sobe Adrenaline Rush, and Impulse Energy Drink (Figure 1).

Charley’s list of questions, which serves to orient students to their task and guides their research (Figure 2).

Ingredients and nutrition facts for the chemical components of each energy drink (Figure 3).

Student task, including a post-research analysis, consisting of a table students complete along with a series of questions; students also compose a concise magazine article reviewing the information they have gathered (Figure 5).

The case can be used as a review of basic biochemistry and nutrition for upper-level students in physiology, biochemistry, or nutrition courses or to introduce this information in introductory courses in these disciplines. We have also used the case successfully in a capstone course for senior biology majors wishing to become secondary teachers. In this setting, the case was used to provide a review of basic biochemistry and nutrition as well as to introduce these students to product analysis. The capstone course involves students in the study of all science disciplines. Students in the course have previously studied biochemistry and human physiology, and have background knowledge in basic metabolism. The case was also used successfully with students who had little formal training in biology at a teacher-training workshop on case studies in science education that took place at Michigan State University in August 2004. In this situation, we assumed our student audience had only a high school knowledge of basic biology and knew generally that sugars make good fuels.

**Objectives**

- Describe and chemically categorize the components of various popular energy drinks.
- Determine the physiological role of these components in the human body.
- Explain scientifically how the marketing claims for these drinks are supported (or not).
- Determine under what conditions each of the energy drinks might be useful to the consumer.
- Write an analysis of energy drinks for a popular magazine.

**FIGURE 3**

**Ingredients and nutrition facts.**

Rhonda was determined to wade through the confusing labeling of the drinks. For example, XS Citrus Blast® boast that it had no calories but still provided “energy.” That made absolutely no sense based on what Rhonda knew about biological energy. The first thing she needed to do was sort out the various ingredients on the labels—a task that consumers rarely undertake.

As in most labels, listed in order of drink mass (highest to lowest):

**XS Citrus Blast**

- Ingredients: carbonated water, L-taurine, L-glutamine, citric acid, adaptogen blend (euletherococcus senticosus, panax ginseng, panax quinquefolium, echinacea purpurea, schisandra, astragalus, and reishi), natural flavors, acerosulfate potassium, caffeine, sodium benzoate, potassium sorbate, sucralose, niacin, pantothenic acid, pyridoxine HCl, yellow 5, cyanocobalamin
- Nutrition facts: serving size: 8.4 fl oz; servings per container: 1; calories: 8; fat: 0g; sodium: 24mg; potassium: 25mg; total carbs: 0g; sugars: 0g; protein: 2g; vitamin B3: 100%; vitamin B6: 300%; vitamin B5: 100%; vitamin B12: 4900%

**Red Bull**

- Ingredients: carbonated water, sucrose, glucose, sodium citrate, taurine, glucuronolactone, caffeine, inositol, niacin, D-pantothenol, pyridoxine HCl, vitamin B2, artificial flavors, colors
- Nutrition facts: serving size: 8.3 fl oz; servings per container: 1; amount per serving: calories: 110; total fat: 0g; sodium: 200mg; protein: 0g; total carbohydrates: 28g; sugars: 27g

**Sobe Adrenaline Rush**

- Ingredients: filtered water, high fructose corn syrup, citric acid, taurine, d-ribose, L-carnitine, natural flavor, inositol, sodium citrate, ascorbic acid, caffeine, monopotassium phosphate, salt, gum arabic, ester gum, siberian ginseng root extract, pyrodoxine hydrochloride, guarana seed extract, caramel color, beta-carotene, folic acid, cyanocobalamin
- Nutrition facts: serving size: 8.3 fl oz; servings per container: 1; amount per serving: calories: 140; total fat: 0g; sodium: 60mg; protein: 1g; total carbohydrates: 36g; sugars: 34g; taurine: 1000mg; d-ribose: 500mg; L-carnitine: 250mg; inositol: 100mg; siberian ginseng: 50mg; guarana: 50mg

**Impulse**

- Ingredients: carbonated water, sucrose, taurine, glucuronolactone, caffeine, inositol, niacinamide, pyridoxine HCl, vitamin C (citric acid), vitamin B12, artificial flavors, colors
- Nutrition facts: serving size: 8.3 fl oz; servings per container: 1; calories: 110; fat: 0g; sodium: 200mg; total carbs: 28g; sugars: 27g; protein: 1g; niacin: 100%; vitamin B6: 250%; vitamin B12: 80%; pantothenic acid: 50%; vitamin C: 100%

**Coca Cola (for later comparison)**

- Ingredients: carbonated water, high fructose corn syrup and/or sucrose, phosphoric acid, natural flavors, caffeine
- Nutrition facts: serving size: 12 fl oz; servings per container: 1; calories: 140; fat: 0g; total carbs: 38g; sugars: 38g; protein: 0g
### FIGURE 4
Energy drink calories

<table>
<thead>
<tr>
<th>Energy drink</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>XS Citrus Blast</td>
<td>8</td>
</tr>
<tr>
<td>Red Bull</td>
<td>110</td>
</tr>
<tr>
<td>Sobe Adrenaline Rush</td>
<td>140</td>
</tr>
<tr>
<td>Impulse</td>
<td>110</td>
</tr>
<tr>
<td>For comparison</td>
<td></td>
</tr>
<tr>
<td>Coca Cola (12-oz)</td>
<td>140</td>
</tr>
</tbody>
</table>

### Classroom management
There is no preparatory homework, and all in-class work is done in groups. The case is designed to be modular and, as a result, can be presented in different ways in different learning situations. The first sections of the case (the case scenario and marketing claims) can be given to students separately or all together, as the instructor wishes. Reading through this material should take students no more than 15 to 20 minutes. The instructor then asks the critical question: “When we say that something gives us energy, what does that mean? What is the biological definition of energy?” Student responses may be listed on the board by the instructor. This question is followed by a 10- to 15-minute class discussion of chemical energy and the biological use of chemical energy and appropriate food sources.

Although the major intent of the case is for students to learn basic biochemistry and nutrition, they also engage in product analysis. Generally, students find energy drinks appealing and believe that they provide an extra kick. Is the kick due to increased energy available, or to the feeling of increased energy? On what basis can they make this evaluation? Can any of the drink components contribute to either kind of kick? Why are these drinks so expensive? Other questions that might be posed in the classroom to generate discussion include:

- What types of components in energy drinks could provide biological energy? Why?
- What is the source of biochemical energy in a sugar-free energy drink?
- According to your research, what other molecules besides sugars are related to the production of biochemical energy? Do these molecules help make the drink an energy drink? Why or why not?
- Does caffeine really increase available chemical energy? Why or why not?
- What is the role of caffeine in some of the energy drinks?
- Why are energy drinks attractive to young people, despite their cost?
- What can an energy drink provide that a can of Coke cannot? Is this worth the extra cost?
- Should a runner consume an energy drink “on the run”? Why/why not?
- Are there sufficient amino acids in the energy drink to affect muscle repair? Is there any way to determine this by looking at the ingredients?
- How can a drink without any source of sugars or carbohydrates claim to be an energy drink?

Next, students are given the list of ingredients and nutrition facts in Figures 2 and 3 and asked to determine what they need to know to match the ingredients list with the marketing claims (15 minutes) and to answer the questions. (The answer key for this case study is available on the website of the National Center for Case Study Teaching in Science at [www.sciencecases.org/energy_drinks/energy_drinks_notes.asp](http://www.sciencecases.org/energy_drinks/energy_drinks_notes.asp)).

### FIGURE 5
Post-research analysis.
Using the information that your group gathered, place each of the ingredients for your drink under the proper heading in the table below.

<table>
<thead>
<tr>
<th>Sources of energy</th>
<th>Amino acids</th>
<th>Stimulants and vitamins</th>
<th>Other—please categorize</th>
</tr>
</thead>
</table>

Questions
When we say that something gives us energy, what does that mean? What is a biological definition of energy?
What is the physiological role of each of the molecules in your table?
Which ingredients provide energy? How do they do that?
Which ingredients contribute to body repair, i.e., help build or rebuild muscle tissue?
In what ways might the one(s) that does (do) not have a metabolic energy source (caffeine) provide the perception of increased energy after consumption?
How are the ingredients in these drinks helpful to someone expending a lot of energy, e.g., a runner?
Does your analysis substantiate the claim that this is an energy drink? If so, what molecules are the sources of energy?
Could your drink serve different purposes for different consumers? Explain.
What is the normal physiological response to increased intake of sugars? To Increased intake of caffeine?
Is there such a thing as a sugar high? Explain your answer. Evaluate, in terms of basic physiology and biochemistry, the statement: A lack of sleep causes a lack of energy.
Are the product claims legitimate? Why?
Should you simply buy a can of Coke rather than one of these energy drinks? Why/why not?
If the rest of the case is done in class, we give students an additional table with biochemical information (see www.sciencecases.org/energy_drinks/energy_drinks5.asp) for each ingredient including its chemical formula, a brief description of what it is (e.g., amino acid), and a brief description of what it does (e.g., aids in muscle building and maintenance). If the case is done over more than one classroom period, instructors can have students find this information on their own and bring it to the next class.

Students then work in their groups to sort the biochemical information and complete the post-research analysis (15–20 minutes), which can be completed on the board, if the instructor wishes. The instructor may choose to recap this analysis before assigning the writing task. The writing assignment can be given to students to complete as homework or it can be completed in class as a group project (approximately 30 minutes).

The case can be completed as either a self-contained, one-day exercise or as an extended, multiday exercise. For a one-day case format (for use with both introductory and advanced students), students are given information for discussion and evaluation in stages: the case and marketing claims; the list of ingredients and nutrition facts; Charley's list of questions; and the biochemical definitions. They discuss the claims of each drink in light of their research to determine biochemical definitions and physiological roles of components. The writing assignment is completed as homework. Running the case in this way should require approximately two hours.

For the multiday case format (for students with a biology background), students are provided with the case and the marketing claims, followed by Charley's list of questions and the list of ingredients and nutrition facts. On their own, students research the chemical nature and physiological function of each chemical component. When students reconvene, they discuss the claims of each drink in light of their research. They can complete the writing assignment in class or as homework. If time constraints limit students from analyzing all of the different energy drinks, each student group can be assigned one energy drink to research.

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