

# Beverages and Satiety... Sorting Out The Science

A Conversation with **DR. ADAM DREWNOWSKI**

The steep rise in obesity around the world has triggered myriad theories about what factors are contributing to this complex issue. One theory suggests this trend is linked to increased consumption of “liquid calories” from sugar-sweetened beverages such as soft drinks, which some have speculated don’t satisfy the appetite as well as calories from solid foods.

But the theory that liquids are less satiating than solid foods is far from conclusive, with some studies showing no difference in their satiating power – and some studies showing that certain liquids are more satiating than many solid foods.

These mixed results raise several provocative questions such as... Are there really differences between the satiating power of calories from beverages and foods? What about the calories from different types of beverages? And how important is our physiology when it comes to the number of calories we consume?

To better understand this issue, the Beverage Institute For Health & Wellness (BIHW) talked with satiety expert and University of Washington professor, Dr. Adam Drewnowski.

**BIHW:** Some media reports suggest that “liquid calories” are a primary cause of obesity. Where did this hypothesis start?

**Dr. Drewnowski:** The original theory was that our bodies are incapable of detecting calories when they are presented in liquid form. Supposedly, liquids fail to stimulate satiety – that is, they don’t satisfy the appetite – in the same way that solid foods are meant to do. So, the speculation was that drinking a caloric soft drink does not make you any less hungry and that you end up consuming more calories overall.

The theory gained a lot of attention after a 2003 World Health Organization report cited it as a cause of obesity.<sup>1</sup> The principal support for the theory seemed to come from only one study.<sup>2</sup> In this study, 15 subjects added 450 calories from solid jelly beans or 450 “liquid” calories from a regular soft drink to their usual eating patterns during two separate four-week periods. When the subjects ate the jelly beans, they compensated for the extra calories by eating fewer calories at other meals and snacks, so their calorie intake stayed the same as usual. But when they consumed the soft drink, they didn’t compensate and ended up consuming more calories than usual.

**BIHW:** But, your satiety research found quite different results. What were your findings?

**Dr. Drewnowski:** We looked at the effects on satiety of solid cookies or liquid cola, each presented at two different times before lunch.<sup>3</sup> We tracked hunger, fullness, and thirst over

**“...the human ability to compensate for extra calories is poor in general.”**

several hours and measured the amount of food consumed at the test meal.

In our study, 32 subjects consumed a 300-calorie snack of fat-free raspberry cookies or regular cola on two occasions each – either two hours (“early”) or 20 minutes (“late”) before lunch. We found that the calories eaten at lunch were not affected by whether the snack was cookies or cola. However, the “late” snacks reduced appetite and led to lower intakes at lunch, regardless of whether they were solid or liquid.

**BIHW:** So, the amount of time between the snack and lunch was more important in determining satiety than whether the calories came from a liquid or a solid?

**Dr. Drewnowski:** That’s exactly right. Hunger, desire to eat, and the amount of calories eaten at lunch were the same for both cookies and cola. We didn’t see a difference in satiety between solids and liquids, suggesting that the body recognized calories from both sources. In other words, in this short-term study all calories were treated the same, regardless of physical form. Liquid calories consumed right before lunch were quite effective in spoiling the appetite, something that several researchers have denied.



**Adam Drewnowski, PhD**

Dr. Drewnowski is the Director of the Center for Public Health Nutrition and Professor of Epidemiology and Medicine at University of Washington. His research addresses the impact of taste, cost, and convenience on food preferences and eating habits and health status disparities. He is also the Director of the NIH-funded UW Center for Obesity Research, which addresses environmental, economic and policy issues to help obesity prevention at the local and state level. He is the author of over 100 research papers, reviews and book chapters, and has developed a nutrient profiling method to classify foods and beverages by their nutrient content.

**BIHW:** Where does the body of research about liquids versus solids and satiety stand at this point?

**Dr. Drewnowski:** The same group that looked at soda and jelly beans recently retested the effects of food form on appetite and energy intakes.<sup>4</sup> This time they compared watermelon and watermelon juice, cheese and milk, and coconut meat and coconut milk. The surprise was that solids did not cause much energy compensation either. Although beverages had a slightly weaker effect, the difference in energy compensation between liquid and solid sugars (watermelon) was only 12 percent. Now, a 12 percent difference is a far, far cry from the original notion that liquids have no satiating power whatsoever.



The Beverage Institute For Health & Wellness is a scientific organization, within The Coca-Cola Company, dedicated to increasing understanding of the role that beverages play in nutrition and health around the world. Visit [www.beverageinstitute.org](http://www.beverageinstitute.org) for more information.

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We have previously reviewed the entire literature on this topic.<sup>5</sup> There are studies showing that liquids are less satiating than solids – but there are also studies showing that soup is more satiating than many solid foods. And of course, liquid formula diets are marketed with the slogan “prevents hunger longer.” So, at this point, the evidence is inconclusive about whether liquids are less satiating than solid foods. It looks like the human ability to compensate for extra calories is poor in general.

**BIHW:** Your research also looked at the impact of different types of liquids on satiety. Why did you investigate this topic and what did you find?

**Dr. Drewnowski:** We were intrigued by this topic because some liquids, such as milk or fruit and vegetable juices were described as “foods that you drink” rather than as beverages. There’s research suggesting that those liquids are good choices for promoting satiety.<sup>6,7</sup> The thought was that regular soft drinks quench thirst, but don’t suppress hunger, while juices and milk can suppress hunger and promote satiety. The satiating power of these beverages was said to be due to their low energy density – which is another way of saying they don’t have very many calories per ounce – so that people end up feeling full on fewer calories.<sup>8</sup>

We thought that was interesting because regular cola has exactly the same energy density as both 1% milk and orange juice (0.4 kcal/g). So, we set out to test whether there really was a difference in their ability to satiate.<sup>9</sup> And because the energy density of the beverages was the same, we were able to use equal volumes of each beverage and equal calories.

We studied 32 volunteers who came to the lab four times to have a breakfast of a slice of dry toast, with either 20 ounces of cola, orange juice or 1% milk – each containing about 250 calories, or, as a control, zero-calorie sparkling water. We found that the cola, juice and milk had identical effects on the subjects’ ratings of hunger, fullness and desire to eat for up to two hours after consumption. So their satiating power was the same. However, there was no compensation at lunch

so that the total energy consumption was higher after milk, juice or cola than after sparkling water.

So, if soft drinks don’t promote compensation, neither do orange juice or 1% milk. Another laboratory obtained identical results when regular cola, orange juice and 1% milk were consumed with a meal instead of before a meal.<sup>10</sup>

**BIHW:** So it seems that humans aren’t very good at compensating for extra calories from either beverages or food. Isn’t this discouraging for people who are watching their weight?

**Dr. Drewnowski:** Our bodies are exquisitely tuned into calorie deficits, meaning that when calories are missing, we seek out more food. Children and athletes are particularly good at this. But, no, most of us aren’t very good at compensating by eating less after consuming extra calories. At least, no physiological mechanism is responsible for this.

But people shouldn’t feel discouraged about this – we’re not totally at the mercy of our physiology. We can use what I call “external vigilance” to control our calorie intake. This means we can think about what we’re going to eat and drink and decide to take measures like watching portion sizes, choosing lower-calorie versions of foods, and balancing the calories in beverages by trimming calories somewhere else in the diet.

**BIHW:** What’s the next study you’d like to conduct to give us a more definitive answer about the relationship between the calories in beverages and satiety?

**Dr. Drewnowski:** Now I am intrigued by a statement from another researcher who said that evolution has rendered humans incapable of recognizing that liquids can even contain calories. He actually said that throughout human history, we had access to nothing but plain water. I have a two-word response: “mother’s milk.” As everyone knows, mammals have evolved drinking mother’s milk, which contains both calories and nutrients. Human agriculture has a long history as well. Granulated sugar was manufactured as early as 510 BC. Food history did not begin yesterday.

*The views expressed by Dr. Drewnowski are his own and do not necessarily represent the views of The Beverage Institute for Health & Wellness or any member of the Beverage Institute Advisory Council.*

<sup>1</sup> World Health Organization. Diet, Nutrition and the Prevention of Chronic Diseases. Issued 2003. Available at: [http://whqlibdoc.who.int/trs/WHO\\_TRS\\_916.pdf](http://whqlibdoc.who.int/trs/WHO_TRS_916.pdf). Accessed August 6, 2007.

<sup>2</sup> DiMeglio DP, Mattes RD. Liquid versus solid carbohydrate: effects on food intake and body weight. *Int J Obes.* 2000;24:794-800.

<sup>3</sup> Almiron-Roig E, Flores SY, Drewnowski A. No difference in satiety or in subsequent energy intakes between a beverage and a solid food. *Physiol Behav.* 2004;82:671-677.

<sup>4</sup> Mourao DM, Bressan J, Campbell WW, Mattes RD. Effects of food form on appetite and energy intake in lean and obese young adults. *Int J Obes (Lond).* 2007 Jun 19; [Epub ahead of print]. Abstract available at: <http://www.nature.com/ijo/journal/vaop/ncurrent/abs/0803667a.html>. Accessed August 6, 2007.

<sup>5</sup> Almiron-Roig E, Chen Y, Drewnowski A. Liquid calories and the failure of satiety: how good is the evidence? *Obes Rev.* 2003;4:201-212.

<sup>6</sup> Kissileff HR, Gruss LP, Thornton J, Jordan HA. The satiating efficiency of foods. *Physiol Behav.* 1984;32:319-332.

<sup>7</sup> Rolls BJ, Fedoroff IC, Guthrie JF, Laster LJ. Foods with different satiating effects in humans. *Appetite.* 1990;15:115-126.

<sup>8</sup> Rolls JB, Barnett RA. *Volumetrics Weight-Control Plan*. 1st ed. New York, NY: HarperCollins Publishers (Quill edition); 2000:21.

<sup>9</sup> Almiron-Roig E, Drewnowski A. Hunger, thirst, and energy intakes following consumption of caloric beverages. *Physiol Behav.* 2003;79:767-773.

<sup>10</sup> DellaValle DM, Roe LS, Rolls BJ. Does the consumption of caloric and non-caloric beverages with a meal affect energy intake? *Appetite.* 2005;44:187-193.



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