Calorie Control Council

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February 18, 2004

Division of Dockets Management
Food and Drug Administration
5630 Fishers Lane, Room 1061 (HFA-305)
Rockville, MD, 20852

RE: Docket No. 2003N-0338

The Calorie Control Council (the "Council") is an international association of manufacturers of low-calorie and reduced-fat foods and beverages. Makers of low-calorie sweeteners, low-calorie bulking agents and fat replacers are among the Council's members.

The Council presented comments at the October 23, 2003 FDA Public Meeting on Obesity and noted in those comments that the Council would be submitting a petition to the agency for a proposed health claim, "Using reduced-calorie foods and beverages, as part of a diet limited in calories, can reduce the risk of obesity. Obesity increases the risk of developing diabetes, heart disease, and certain cancers."

Enclosed are copies of the Council's October 23 comments and the petition with its attachment that has now been submitted to the FDA.

Respectfully submitted,

Lyn O'Brien Nabors
Executive Vice President

Enclosures

2003N-0338 C 19

FDA Public Meeting on Obesity

October 23, 2003
9:00 to 5:00 p.m.
Warren Grant Magnuson Clinical Center
Masur Auditorium (Bldg 10)
National Institutes of Health
9000 Rockville Pike
Bethesda, MD

Calorie Control Council Comments
Lyn O'Brien Nabors, Executive Vice President

The Calorie Control Council is an international association of manufacturers of low-calorie and reduced-fat foods and beverages. Makers of low-calorie sweeteners, low-calorie bulking agents and fat replacers are among the Council's members. I am Lyn Nabors, Executive Vice President, of the Council. The Council is pleased to present the following comments.

Secretary Thompson, recently addressing the 2005 Dietary Guidelines Advisory Committee, noted that he comes from a state that loves milk, cheese, beer and brats and asked the Committee if they could make them have fewer calories. The good news is that such products are already available along with hundreds of other good tasting reduced calorie products.

The bad news is consumers may not be using these products appropriately. According to the Calorie Control Council's most recent consumer research on light product usage, 87% of American adults say they use light products on a regular basis – defined as at least once every two weeks. The majority of users consume these products several times per week and say they want more. However, 36% of those who say they need to lose weight admit that they often splurge on favorite full-calorie foods.

Dr. James Hill of the University of Colorado recently reported that people are gaining an extra two pounds per year or 14 to 16 pounds over an eight-year period. He notes that a simple approach to preventing this weight gain is to cut out just 100 calories per day. This "one hundred calories per day" can be cut by using reduced-calorie products in place of their full calorie counterparts. For example, simply substituting a packet of low-calorie tabletop sweetener for sugar in coffee, on cereal and in ice tea three times a day is a savings of about 100 calories. Consuming eight ounces of a "light" yogurt sweetened with low calorie sweeteners in place of a low-fat yogurt saves about 140 calories, choosing a cup of skim milk in place of whole milk saves 60 calories, substituting a serving of sugar-free gelatin dessert for its traditional counterpart saves 70 calories, using fat free potato chips in place of regular chips saves 75 calories per ounce, replacing a regular soda with a can of diet soda saves 150 calories, and the list goes on and on.

It is a well known that weight loss is the result of expending more calories than consumed. Additional calories would, therefore, need to be cut from the diet or activity increased – and preferably both – in order to lose weight.

Low-calorie sweeteners and the products containing them provide sweetness and "good taste" without the calories of their full calorie counterparts. Research demonstrates that when sucrose is covertly replaced with low-calorie sweeteners non-dieting obese and normal weight individuals incompletely compensate for the calorie reduction. In other words, they consume fewer calories.

Importantly, a 3-year scientific study conducted at Harvard Medical School showed that the low-calorie sweetener, aspartame, was a valuable aid to a long-term weight management program that included diet and physical activity.

And, a recent study to determine the impact of reduced calorie foods and beverages (i.e., products sweetened with low-calorie sweeteners) was undertaken to determine the quality of the diets of American adults. The micronutrient quality of the diet of those using reduced-calorie products was significantly better than those who did not use such products and energy intake was reduced.

Clearly, there are significant benefits when products reduced in calories are incorporated into a sensible diet. Today, the Council proposes labeling that would make low calorie foods more attractive to consumers and allow food and beverage manufacturers to more favorably position their products. The proposed labeling would also assist in educating consumers about the risks of obesity and the important role reduced-calorie products can play.

Thus, please consider for approval the following: "Using reduced-calorie foods and beverages, as part of a diet limited calories, may reduce the risk of obesity. Obesity increases the risk of developing diabetes, heart disease, and certain cancers."

We trust the FDA will give serious consideration to this proposed health claim and the Council will formally propose such labeling to the agency with additional supporting data shortly.

Thank you.

Calorie Control Council

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February 18, 2004

Food and Drug Administration
Office of Nutritional Products, Labeling and Dietary Supplements (HFS-800)
5100 Paint Branch Pkwy.
College Park, MD 20740

RE: Citizen Petition -- Reduced Calorie Foods in Reducing the Risk of Obesity

The Calorie Control Council (the "Council") submits this petition under Sections 403(r)(4) of the Federal Food, Drug, and Cosmetic Act ("the Act") with respect to the health claim "Using reduced-calorie foods and beverages, as part of a diet limited in calories, can reduce the risk of obesity. Obesity increases the risk of developing diabetes, heart disease, and certain cancers."

The Council is an international association of manufacturers of reduced calorie foods and beverages, including the manufacturers of a variety of sweeteners, fat replacers and other low calorie ingredients used in those products.

1. Action Requested

The Council requests that the Food and Drug Administration (FDA) approve, in accordance with November 25, 2003, FDA Advance Notice of Proposed Rulemaking on Food Labeling: Health Claims; Dietary Guidance, the use in food labeling a health claim stating: "Using reduced-calorie foods and beverages, as part of a diet limited in calories, can reduce the risk of obesity. Obesity increases the risk of developing diabetes, heart disease, and certain cancers."

II. Statement of Grounds

Obesity has reached epidemic proportions in the U.S. and is a major concern of all levels of the government (federal, state and local), the public health community, health professionals, as well as the food industry. It is well established that weight loss is the result of consuming fewer calories than expended. The use of reduced and low calorie foods and beverages can assist consumers in reducing their caloric intake and when used as part of an overall reduced calorie diet can result in weight loss.

Reduced and low-calorie foods use a wide variety of techniques to achieve their caloric reduction, these include using approved ingredients, such as intense sweeteners, polyols, fat replacers, and low-calorie bulking agents. All these ingredients are Generally

Recognized As Safe or approved food additives. The basis of the usefulness of these foods is set forth in Attachment 1, "The Benefits of Reduced-Calorie Foods and Beverages in Weight Management."

There is general recognition of the benefits of weight control in reducing the risk of disease. For example, "The Surgeon General's Call To Action To Prevent and Decrease Overweight and Obesity" lists a number of health consequences for overweight and obesity, including premature death, heart disease, diabetes, some types of cancer, breathing problems, arthritis and reproductive complications.[1]

III. Environmental Impact

This petition is entitled to a categorical exclusion from the requirement to prepare an environmental assessment under 21 CFR 25.24(a)(11) because positive action on this petition would result in the revision of existing food labeling requirements without increasing the intended uses of any product.

IV. Certification

The undersigned certifies, that to the best knowledge and belief of the undersigned, this petition includes all information and views on which the petition relies, and that it includes representative data and information known to the petitioner that are unfavorable to the petition.

Respectfully submitted,

Lyn O'Brien Nabors
Executive Vice President

[1] http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact_consequences.htm

Attachment 1

The Benefits of Reduced-Calorie Foods and Beverages in Weight Management

Obesity has reached epidemic proportions. In the U.S. alone, 65 percent of adults are overweight or obese and 15 percent of children and adolescents are overweight. Obesity in adults has more than doubled from 15 percent in 1980 to 31 percent in 2000. The prevalence of overweight in children and adolescents, ages 6-19 years, has more than doubled in the same time period as well.

Both obesity and the struggle to lose weight are extremely complex, involving many factors in addition to diet, such as hereditary, environmental and psychological influences. The psychological burden of obesity is perhaps as damaging as the physical complications of the disease (Brownell, 1984, Allon, 1973). Obesity is, too often, unfortunately associated with laziness, lack of self-control and lack of concern about physical appearance (Brownell and Wadden, 1992; Allon, 1973).

Today there is a growing awareness of the serious health risks related to obesity, including high blood pressure, diabetes, coronary heart disease and certain types of cancer. As a result, sensible dieting and fitness are increasingly important to many.

It is well established that losing weight is the result of consuming fewer calories than expended. Health experts agree that weight loss is best achieved by a combination of reducing caloric intake and increasing exercise/activity but can be accomplished more slowly by a reduction in caloric intake or exercise alone. Weight management results from balancing food intake with energy expenditure.

Low-calorie sweeteners can play an important role in reducing calorie intake. "Light" foods and beverages containing low-calorie sweeteners, reduced in sugar and/or calories, provide good tasting products that are significantly lower in calories than their full calorie counterparts. A broad range of good tasting light products is widely available.

According to Gallup Consumer Surveys, almost half of adults believe they are getting too much sugar in their diets, and efforts to avoid sugar are at the highest levels in a decade. Consumers are most likely to look at both the calorie and sugar content on the nutrition label. In addition, about two-thirds of mothers believe their children are consuming too much sugar – which represents the single ingredient that mothers are most concerned about monitoring.

There are currently five low-calorie sweeteners approved for use in the U.S. All provide no calories to foods and beverages and have been determined to be safe for use by the general population. They are among the most thoroughly tested ingredients, both individually and as a group, in the food supply. All have been carefully reviewed and deemed safe by the U.S. Food and Drug Administration (FDA) and numerous other regulatory bodies and expert committees around the world, including the Joint Expert Committee on Food Additives of the World Health Organization and Food and Agriculture Organization (JECFA). The sweeteners have been determined safe by health organizations such as the American Diabetes Association (2002) and the American Dietetic Association (2004) as well. In addition, the American Dental Association (1998) has approved a position statement acknowledging the "Role of Sugar-Free Foods and Medications in Maintaining Good Oral Health." The low-calorie sweeteners currently available for use in the U.S. are acesulfame potassium, aspartame, neotame, saccharin and sucralose.

Dr. James Hill (2003) of the University of Colorado recently reported that people are gaining an extra two pounds per year or 14 to 16 pounds over an eight-year period. He notes that a simple approach to preventing this weight gain is to cut out just 100 calories per day. This "one hundred calories per day" can be cut by using reduced-calorie products in place of their full calorie counterparts. For example, simply substituting a packet of low-calorie tabletop sweetener for sugar in coffee, on cereal or in ice tea three times a day is a savings of about 100 calories. The chart below shows the number of calories that may be saved by substituting reduced calorie products sweetened with low-calorie sweeteners for their full calorie counterparts.

Calories Saved

Use	In Place of:	Calories Saved
Sugar-free pudding (1/2 cup)	Pudding	70
Table top sweetener (one packet)	Sugar (2 tsp)	32
Sugar-free syrup (1/4 cup)	Syrup	180
Sugar-free preserves (1 tbsp)	Preserves	40
No-sugar added ice cream (1/2 cup)	Ice Cream	60
Sugar-free gelatin (1/2 cup)	Gelatin	70
Light lemonade powered drink mix (8 oz.)	Lemonade powdered drink mix	55
Fat-free, light yogurt (8 oz. container)	Fat-Free Yogurt	140
Diet soda (12 oz.)	Regular Soda	150
Light cheesecake (1 slice)	Cheesecake	100
Light cranberry juice cocktail (8 oz.)	Cranberry juice cocktail	90

Desire for Sweet Taste

The desire for sweet foods is not a recent phenomenon. There is historical evidence that humans have always had a preference for sweets. Examples include a 20,000-year-old cave painting of a man robbing a wild bees' nest and drawings of honey production in ancient Egyptian tombs (Pfafmann, 1977). Also, research has shown that the desire for sweets is inborn. Newborn infants have long been observed to react positively to sweetness, and a fetus at five months has been reported to respond positively to sweet-tasting stimuli (Maller and Desor, 1973). Studies with adults, as well as infants, have demonstrated that the pleasant response to sweet is an innate, reflex reaction rather than a learned response (Pfafmann, 1977; Maller and Desor, 1973; Beidler, 1975; Steiner, 1973).

Some have claimed that low-calorie sweeteners perpetuate a desire for sweet foods and may stimulate appetite – thereby leading to increased food intake and weight gain. Such claims are essentially speculation and not well founded scientifically. Importantly, scientific evidence points to the opposite conclusion, i.e., that low-calorie sweeteners do not stimulate appetite or food intake, nor do they cause weight gain. Low-calorie sweeteners and the reduced-calorie products containing them, in fact, may assist in reducing calorie intake and consequently weight.

Clinical Evidence: Body Weight

Scientific evidence supports the effectiveness of low-calorie sweeteners in helping control caloric intake. Historically, research was limited because: 1) low-calorie sweeteners are not drugs where efficacy can be readily determined clinically, and 2) until the approval of aspartame, it was almost impossible to devise a double-blind crossover study using low-calorie sweeteners. (Because the taste of saccharin -- the only low-calorie sweetener available for most of this century -- is distinct from that of sucrose, subjects could immediately detect its presence.) The availability of aspartame has made it possible to investigate more thoroughly the value of low-calorie sweeteners in weight management. Research now documents that consumption of low-calorie sweeteners can be useful in weight-loss efforts.

A six-week clinical study (Berryman et al., 1968) evaluated the effects of covert calorie dilution on body weight. Saccharin and cyclamate were covertly substituted for sugar in canned fruit and beverages in 25 subjects over a 41-day period. Male subjects lost an average of 3.7 pounds and females an average of 2.1 pounds, compared to an insignificant gain by the control group.

Kanders et al. (1988, 1996) evaluated the effect of aspartame on control of body weight in obese subjects. Fifty-nine obese men and women were recruited to participate in a pilot study with a 12-week multidisciplinary diet program. Recruits were randomly assigned to consume a nutrient balanced deficit diet (1000 ± 200 kcal/day) with or without aspartame. Although not statistically significant, women in the aspartame group (N=24) lost 3.7 pounds more than women in the no-aspartame group (N=21). Men showed the opposite trend, with those in the no-aspartame group (N=7) losing about 4 pounds more than those in the aspartame group (N=4).

Forty-six of these subjects (11 males and 35 females) participated in a one-year follow-up study. Increased levels of physical activity, increased consumption of aspartame, and decreased desire for sweets were associated with maintenance of weight loss at the one-year follow-up. Aspartame intake at the end of follow-up was associated with better weight maintenance in male subjects. Although the small sample size prevents definitive conclusions, aspartame consumption did not cause weight gain and may be beneficial in promoting weight loss and maintenance when used as part of a multidisciplinary weight control program.

Blackburn et al. (1997) conducted a randomized, controlled, prospective clinical follow-up study to investigate whether the addition of aspartame to a multidisciplinary weight control program would improve weight loss and long-term control of body weight in obese women. One hundred sixty-eight obese women aged 20 to 60 years were placed on a nutrient-balanced deficit diet (1000 ± 200 kcal/day) for three weeks. At the end of this time, the subjects were instructed to continue the balanced deficit diet and were randomly assigned either to consume aspartame-sweetened foods and beverages during the remaining 16 weeks of the active weight loss phase of the study or to avoid such products. During the one-year weight maintenance phase and two-year follow-up periods, participants were encouraged to continue to consume or avoid aspartame-containing products according to their original group assignment.

During the active weight loss period, all subjects attended weekly one-hour sessions with instruction on behavioral and lifestyle strategies to facilitate weight loss. During the 12-month maintenance and the 19-month follow-up, the groups met monthly. Throughout the study, regular exercise, mainly walking, was strongly encouraged. Body weight, aspartame intake, exercise level and subjective ratings of hunger, desire for sweets and eating control were evaluated at baseline, 19, 71, and 156 weeks.

One hundred thirty-six subjects completed the active weight loss phase; 125 subjects completed the maintenance phase; and 86 subjects completed the follow-up phase. Subjects in both treatment groups lost a mean of approximately 10% of body weight (10 kg) during the 19 weeks of active weight loss. Among subjects in the aspartame group, aspartame consumption was positively associated with weight loss. The desire for sweets decreased significantly in the aspartame group but not in the no-aspartame group; hunger did not differ significantly from baseline in either treatment group, but eating control increased significantly in both treatment groups. Hunger and desire for sweets remained unchanged within both treatment groups during the maintenance phase (weeks 19 –71). Eating control decreased significantly in both maintenance and follow-up phases in both groups, suggesting more uncontrolled eating during maintenance and follow-up.

At the end of the maintenance phase (Week 71), subjects in the aspartame group experienced a 3.1% mean weight regain, and those in the no-aspartame group regained a mean of 4.9%. By the end of the follow-up phase (Week 156), subjects in the aspartame group had regained an additional 2.4%, with a net weight loss from baseline of 5.1%. In contrast, subjects in the no-aspartame group had a gain of 5.4%, with a net weight loss of 0.3% from baseline. Significant predictors of better weight control from baseline to Week 156 included increased exercise, increased self-reported eating control, and initial treatment group assignment, where aspartame group subjects had an advantage over the no-aspartame group subjects. The researchers concluded that aspartame, as part of a multidisciplinary weight control program, may facilitate weight control.

Aspartame was associated with weight loss in two additional multi-week studies. Morris et al. (1989) investigated low-calorie sweetener consumption patterns of 35 overweight individuals before and after completing a 16-week weight loss program. The program consisted of either a low-fat diet or a low-fat diet combined with regular exercise. Each subject's use of saccharin and aspartame was self-reported via food diaries.

At the end of the 16-week period, women lost more than 15 pounds and men lost more than 20 pounds while consuming aspartame and saccharin. Women increased their intake of low-calorie sweeteners by 34 percent (from 281 to 377 mg/day) by the end of the study. The researchers concluded: "These results suggest that consumption of artificial sweeteners is not a barrier to weight loss and that foods containing artificial sweeteners can be incorporated into a weight-loss program."

Tordoff and Alleva (1990) conducted a long-term study monitoring the diet records and body weights of 30 normal-weight adults during three separate periods, each lasting three weeks. During each period, the subjects consumed 40 ounces daily of aspartame-sweetened soda or high fructose corn syrup (HFCS) sweetened soda or no experimental drinks.

The researchers observed that drinking aspartame-sweetened soda decreased the sugar and calorie intake of both sexes significantly compared to the control period. Consumption of aspartame-sweetened soda also led to a non-significant decrease in body weight in both sexes combined, while consumption of HFCS-sweetened soda resulted in a significant weight gain in both men and women.

The researchers noted that although some studies have associated low-calorie sweeteners with an increase in appetite and short-term food intake, this study showed that "drinking large volumes of aspartame-sweetened soda. . . . reduces sugar intake and thus may facilitate the control of calorie intake and body weight."

Raben et al. (2002) conducted a 10-week study in which overweight subjects were given either supplemental drinks or food containing sucrose or similar drinks and foods containing artificial sweeteners. Those consuming sucrose containing products experienced increases in total energy intake, body weight, fat mass and blood pressure. This was not observed in subjects consuming "artificial sweetener" containing products. The authors concluded that the most likely reason for the differences between the groups was the use of large amounts of beverages, resulting in over consumption of energy on the high-sucrose diet and suggest that those overweight may want to consider choosing beverages containing "artificial sweeteners" rather than sucrose to prevent weight gain.

Rolls (1991) has published a review of 45 studies examining the effects of low-calorie sweeteners on hunger, appetite and food intake, which provides compelling evidence that low-calorie sweeteners are helpful in controlling weight. From her review, which included a thorough discussion of the major allegations related to the benefits of low-calorie sweeteners, Rolls concluded: "Preliminary clinical trials suggested that aspartame may be a useful aid in a complete diet-and-exercise program or in weight maintenance. Intense sweeteners have never been found to cause weight gain in humans." She added, "If the individual uses the consumption of a low-calorie food as an excuse to eat a high-calorie food, or if the individual is not actively trying to restrict intake, daily energy intake may remain unchanged. However, if intense sweeteners are part of a weight-control program, they could aid calorie control by providing palatable foods with reduced energy. It needs to be stressed that there are no data suggesting that consumption of foods and drinks with intense sweeteners promotes food intake and weight gain in dieters."

The existing clinical evidence contradicts any suggestion that low-calorie sweeteners cause people to overcompensate for the calories saved in a given meal by eating more in a later meal. Additionally, extensive clinical research shows that low-calorie sweetener use does not result in increased calorie intake or lead to weight gain and may assist with weight loss and control.

Other Studies Assessing Food/Caloric Intake

Clinical evidence indicates that low-calorie sweeteners are effective in limiting calorie intake. In pioneering work in this area, Porikos and colleagues investigated the effect of covert caloric dilution on food intake in three separate clinical studies (Porikos et al., 1977; Porikos et al., 1982; Porikos and Pi-Sunyer, 1984; Porikos and Van Italie, 1984). In one study, the diet of six normal-weight male subjects was reduced calorically by 25% by the covert substitution of aspartame-sweetened analogs for all menu items containing sucrose (Porikos et al., 1982). Although the subjects compensated somewhat for the caloric dilution, their caloric intake stabilized at 15 percent below their normal intake. The subjects did not show a shift in either sweetened or unsweetened food choices while their diet was being diluted, which contradicts claims that low-calorie sweeteners may encourage a desire for sweets.

In another study conducted by Porikos et al. (1977), the covert substitution of aspartame for sucrose in the diets of obese adults resulted in a 25 percent reduction in caloric intake. In a third caloric dilution study of obese and normal weight subjects, Porikos reported that obese subjects reduced their caloric intake by 16 percent compared to a baseline diet, and normal weight subjects reduced caloric intake by 16 percent (Porikos and Pi-Sunyer, 1984; Porikos and Van Italie, 1984). Dr. Porikos concluded from her research that foods and beverages containing low-calorie sweeteners can offer an effective approach to dieting, noting: "They allow for a reduction in energy intake without alteration in taste and only minor changes in volume of diet. A dietary regimen which includes low-calorie versions of people's favorite foods, particularly sweets, should encourage compliance" (Porikos and Van Italie, 1984).

Rolls also has conducted research regarding the effects of low-calorie sweeteners on caloric intake and hunger. In a study of 42 normal-weight men, the subjects were given 8 to 16 ounces of lemonade, sweetened to equal intensity with either aspartame or sucrose, or the same volumes of water, or no drink (Rolls et al., 1990). Subjects were separated into three groups receiving the drinks at different times: with a self-selection lunch or 30 or 60 minutes before lunch. Researchers found that there was no instance in the three experiments in which hunger ratings or intake under the aspartame versus water conditions differed, and concluded, "Thus these data do not support the hypothesis that aspartame-sweetened drinks increase food intake."

In a study conducted by Drewnowski et al. (1994), the effects of four breakfast preloads on hunger ratings, energy intakes and taste responsiveness profiles were examined in 24 normal-weight adults. The breakfasts consisted of 400 g of creamy white cheese ("fromage blanc") with maltodextrin or water, and differed in energy value (700 kcal vs. 300 kcal) and the nature of the sweetener. High-calorie breakfasts were sweetened with sucrose or with aspartame, while low-calorie ones contained aspartame or were not sweetened at all. Daily energy intakes following breakfast were the same for all four breakfasts. No calorie compensation was observed: subjects given 300 kcal breakfasts had lower total daily intakes than when given 700 kcal. The researchers concluded, "These data do not support the notion that intense sweeteners increase hunger or result in increased energy intakes in normal-weight subjects."

Blundell, Rogers and colleagues have speculated that low-calorie sweeteners can affect appetite and caloric intake via postingestive effects. According to this theory, when low-calorie sweeteners bypass the sweet taste, i.e., when administered in capsule form, they affect certain hormones involved in appetite regulation.

In two separate clinical studies, these researchers investigated the effects of encapsulated aspartame on motivation to eat and caloric intake. In the first study, food intake was measured in 27 normal-weight individuals following preloads of 234 or 470 mg of encapsulated aspartame, 234 mg of aspartame dissolved in water, or a placebo (control) (Rogers et al., 1990).

The encapsulated aspartame reduced motivation to eat and significantly reduced calorie intake one hour later compared with both the aspartame solution and control preloads. The 234 mg dose reduced intake by between 9 and 14 percent (138 and 175 calories). The 470 mg dose had a similar effect, reducing intake by 150 calories. The aspartame solution and control preloads did not significantly alter motivational ratings or food intake. It should be noted that Blundell's data in the study regarding motivation to eat are contradicted by those of his previous two studies where he reported that aspartame in water stimulates appetite. The researchers concluded: "The results provided clear evidence of a predominant postingestive inhibitory action of aspartame on appetite . . .."

In a subsequent double-blind study, Blundell and his colleagues (Rogers et al., 1991) measured hunger and food intake in 16 adults following a preload of encapsulated aspartame or its breakdown components, L-aspartic acid or L-phenylalanine. On the same day for four consecutive weeks, the subjects were given either 200 mg L-aspartic acid, 200 mg L-phenylalanine, 400 mg aspartame or placebo one hour before a self-selected test meal. None of the treatments had a significant effect on hunger, either before or following the test meal. However, the aspartame treatment reduced food intake at the test meal by 15 percent compared with the placebo, while aspartame's components had no significant effect on intake. Aspartame also did not result in a rebound increase in hunger in the post meal interval (3 1/2 hours). Noting the absence of increased hunger despite the reduced intake, the researchers concluded: "This suggests that aspartame may act to intensify the satiating effects of ingested food."

Black et al. (1993) compared the effects on appetite and food intake of different volumes of beverage, beverages with aspartame in solution, and beverages with aspartame in capsules. In contrast to Rogers et al. (1990), Black et al. (1993) reported that aspartame in capsules had no effect on appetite. Furthermore, the researchers concluded that appetite reduction after consumption of an aspartame-sweetened beverage is likely due to the volume of the drink and not the aspartame.

Numerous other studies, utilizing various methodologies, have evaluated the effect of aspartame on hunger, appetite and food intake. Replacing sucrose with aspartame in foods or beverages has not been shown to increase food intake or hunger in children (Anderson et al., 1989; Birch et al., 1989) and has not been shown to increase food intake in normal weight (Blundell and Hill, 1987; Rolls et al., 1989, 1990; Black et al., 1991; Canty and Chan, 1991; Drewnowski et al., 1994, 1994a) or in overweight men and women (Rodin, 1990; Drewnowski, 1994a). Interestingly, all of these studies reported either unchanged or reduced motivation to eat regardless of whether the aspartame was delivered in a solid or liquid form.

Wilson (2000) compared the effect of plain milk, sucrose-sweetened milk, and aspartame-sweetened milk on mealtime caloric intake in young children. Children consumed more sweetened milk than plain milk. However, the researchers found that young children do not reduce caloric intake at a meal to compensate for the extra calories resulting from sucrose-sweetened milk whereas aspartame increased milk consumption without providing the extra calories of sucrose-sweetened milk. Studies on aspartame, appetite, and food intake have been reviewed in detail by Rolls (1991), Renwick (1994), Drewnowski (1995), and Rolls and Shide (1996). As Rolls and Shide (1996) concluded, "From evaluation of the available data, there is no consistent nor compelling evidence that the intense sweetener aspartame increases food intake or body weight."

Research on Hunger and Appetite

Research also has been conducted investigating the effect of low-calorie sweeteners on hunger and appetite. A human study conducted by Blundell and Hill (1986), reported in a letter-to-the editor of *The Lancet*, investigated the effects of aqueous solutions of sugar or aspartame, or plain water on feelings of hunger versus fullness. An orally administered aspartame solution (162 mg/200 ml) reportedly was found to increase ratings of motivation to eat and decrease ratings of fullness. The researchers only measured subjective feelings of hunger and not whether food intake actually increased following the subjects' reports of "residual hunger" after aspartame ingestion; no food was offered to test actual behavior. The researchers do not state whether their study was performed under double-blind, controlled conditions. Blundell and colleagues (Rogers et al., 1988) have completed further research suggesting that solutions of saccharin and acesulfame-K also increase hunger ratings compared with water, but none of these sweeteners was found to increase food intake one hour later. It should be noted that the same researchers (Rogers et al., 1990) failed to replicate their findings of an appetite-stimulating effect of an aqueous aspartame solution in a later study.

Rogers and Blundell (1989) extended their investigations to examine food in a clinical study, which measured the effects of saccharin on hunger and food intake. The normal-weight subjects consumed a fixed amount of yogurt sweetened either with saccharin or glucose, with no sweetener, or with starch and saccharin, followed by lunch one hour later. Food intake was significantly greater throughout the day following consumption of the saccharin-sweetened yogurt (without starch) compared with the plain, unsweetened yogurt. The researchers theorized that the increase in intake may have been related to the sweetness of the yogurt and not to the saccharin itself, since the yogurt containing saccharin plus starch did not lead to greater intake than the equicalorie glucose-sweetened yogurt.

Tordoff and Alleva (1990a) reported in their study of the effects of sweetness without calories on hunger that chewing an unflavored gum base with varying concentrations of aspartame increased ratings of hunger, but not proportionately with increases in aspartame concentration. Instead, subjects rated themselves hungrier after chewing moderate (.3 percent or .5 percent) rather than high (1.0 percent) concentrations of aspartame. As the researchers did not measure food intake, one cannot infer from this study that aspartame's sweet taste can affect subsequent eating behavior. Noting several variables in this study, which affected ratings of hunger, the researchers concluded, "The results of this study point out the fragility of the influence of sweetness on appetite."

Other research argues against the claim that low-calorie sweeteners may increase appetite. Rolls (1987) investigated the effect of aspartame versus sucrose on hunger and satiety. In a study of normal weight adults who were offered gelatin sweetened covertly with either sucrose or aspartame, subjects ate a constant weight of food despite the difference in calories. Hunger was suppressed equally by both desserts over the past hour, but there was no compensation for the caloric difference when additional food was offered an hour later. Rolls concluded "it is clear that low energy sweeteners can be as satisfying as sugars during a meal, particularly when the subjects are unaware of the caloric manipulation."

In a subsequent study, Rolls et al. (1989) covertly substituted aspartame for sugar in gelatin or pudding preloads served to normal-weight adults two hours before a self-selection meal. Half of the 32 subjects were aware of the caloric manipulation, half were not. Both informed and uninformed subjects consumed significantly fewer calories from the aspartame preloads compared with the sucrose preloads. In the two-hour period between the preload and the test meal, both the low and high-calorie versions of the test foods equally suppressed ratings of hunger and the desire to eat. Total intake of the preload and subsequent meal did not differ significantly between the sucrose and aspartame conditions. Awareness of the low caloric content of the aspartame-containing preloads did not cause these subjects to eat more at the subsequent meal. The researchers concluded: "Aspartame-sweetened foods can be of benefit in reducing hunger and increasing satiety."

Using a different study method, Mattes (1990) evaluated the effects of sucrose and aspartame on hunger and food intake by keeping the calories and rated pleasantness of a test meal constant. The study's 24 normal-weight subjects consumed equicaloric breakfasts of either unsweetened cereal (control) or cereal sweetened with sucrose or aspartame. Half the subjects were aware of the cereal composition, half were uninformed. There were no significant differences in hunger ratings up to three hours following the meal and no significant difference in food intake throughout the day. The authors concluded. "The present data indicate that the use of aspartame in foods does not stimulate energy intake . . .."

A study of Leon et al. (1989) investigated the effects of aspartame in 108 adults who received either 75 mg/kg of encapsulated aspartame (equivalent to approximately 10 liters of aspartame-sweetened beverage) or a placebo daily for 24 weeks. The study revealed no significant change in body weight of participants consuming aspartame. Citing numerous studies which failed to show any correlation between low-calorie sweetener intake and hunger or weight gain, the researchers refuted Blundell and Hill's claim that aspartame may increase appetite and concluded, "Taken together, these studies argue against a 'paradoxical' effect of aspartame on appetite."

The effects of low-calorie sweeteners consumed in beverages on hunger and calorie intake were investigated in two studies. In a study by Black et al. (1991), the aspartame-sweetened preload was given three hours after a standard breakfast. The researchers noted the importance of controlling food intake prior to a test load as this may mask the effects of a low-calorie sweetener on subsequent food intake. The 20 normal-weight subjects consumed either 12-ounces or 24-ounces of an aspartame-sweetened soft drink, or water, one hour before a test lunch. Consumption of the 24-ounce preload significantly reduced hunger in the one-hour period following the preload, compared with mineral water and the 12-ounce preloads. None of the preloads had any effect on calorie intake. The researchers concluded, "(these) results add support to the growing body of evidence indicating that the consumption of foods and beverages containing nonnutritive sweeteners do not increase hunger and food intake."

In a similar study by Canty and Chan (1991), the effects of saccharin as well as aspartame were evaluated. Twenty normal-weight subjects consumed approximately seven ounces of water or soft drink sweetened with saccharin, aspartame or sucrose, or water three hours following a standard breakfast and one hour before ad libitum consumption of a standard lunch. Overall, consumption of saccharin and aspartame did not increase hunger or food consumption compared with water. In fact, hunger ratings in the hour between preload consumption and lunch were generally highest for water, followed by aspartame, saccharin and sucrose. The researchers also found no significant differences in calorie intake associated with any of the preloads.

Research on the possible neurochemical effects of aspartame and phenylalanine (an amino acid component of aspartame) on hunger and food intake (specifically the balance of protein, carbohydrate and fat) was reported by Ryan-Harshman et al. (1987). This research involved two separate double-blind tests in normal weight men. In the first test, subjects were given varying levels of phenylalanine in capsule form one hour before lunch. In the second test, doses of both phenylalanine and aspartame were administered 105 minutes before eating. Tests using visual analog scales were administered at intervals before and after eating to assess subjective feelings of hunger and mood. Blood samples were taken from some subjects for plasma amino acid analysis.

The researchers found that plasma phenylalanine levels and ratios to competing amino acids rose significantly with all treatments except the lowest phenylalanine doses. However, in all doses studied, including a dose of 10 grams (10,000 mg), neither aspartame nor phenylalanine affected calorie intake nor did they significantly affect intake ratios of protein, carbohydrate or fat. Also, no consistent relationship existed between plasma amino acid levels and food intake among the individuals who participated in the biochemical analysis. The researchers concluded that, in the doses studied, aspartame and phenylalanine "do not affect short-term energy and macronutrient intakes, and subjective feelings of hunger . . .."

Insulin and Hunger

Some researchers have suggested that sweetness, including that provided by low-calorie sweeteners, increases hunger and attribute this to a proposed effect on insulin response (Rodin, 1984; Remington, 1985; Rodin, 1984a). Claims have been made that the body responds to low-calorie sweeteners as it does to sugar by triggering insulin release, which lowers blood sugar and stimulates hunger (Rodin, 1984; Remington, 1985). The claim has little basis in science.

Human studies have demonstrated that low-calorie sweeteners do not significantly affect insulin levels (Goldfine et al, 1969; Ambrus et al., 1976; Okuno, et al, 1986; Carlson and Shah, 1989; Horwitz et al., 1988). Although some studies have indicated an initial insulin response in animals and humans given orally administered saccharin solutions (Von Borstel, 1985; Louis-Sylvestre, 1976; Berthoud, 1981), two phases of insulin release normally occur when carbohydrates are consumed. The first, cephalic phase is marked by an immediate small rise in plasma insulin and accounts for only a small portion of the total insulin released. Von Borstel (1985) reported that this initial insulin release could be triggered by the mere taste, smell or other sensory qualities of food. The second phase begins several minutes later and lasts until blood sugar is normalized (Garong, 1973). Early research indicated that only the cephalic phase of insulin secretion might be observed in animals and humans consuming low-calorie sweeteners, and then only some of the time (Von Borstel, 1985). Bruce et al. (1987) failed to observe a cephalic phase insulin release in human subjects given aspartame-sweetened water. Low-calorie sweeteners have not been found to trigger the second phase, which accounts for the majority of total insulin released in response to carbohydrate consumption.

Rodin (1990) subsequently conducted research to investigate her theory that low-calorie sweeteners stimulate appetite. In a study of 24 normal and overweight subjects, caloric intake and insulin levels were measured following a preload solution of fructose, glucose or aspartame, or water. Overall, there was no significant difference in intake following the aspartame, glucose or water preloads. Aspartame also had no effect on blood glucose or insulin levels. Rodin concluded, "The data on aspartame showed that, overall, an aspartame-sweetened drink does not lead to significantly greater subsequent food intake than does a preload of plain water. Thus aspartame -- at least under present conditions -- does not appear to have the stimulating effect on food intake that Blundell et al. suggested."

Five more recent clinical studies further refute the insulin theory by showing no effect on insulin levels following aspartame and/or saccharin administration. Researchers Carlson and Shah (1989) examined the effects of encapsulated aspartame or its constituent amino acids as well as solutions of aspartame on levels of blood glucose, insulin and other hormones in 16 normal-weight adults. The researchers found no significant changes in blood levels of the hormones monitored. Interestingly, all tests resulted in slightly lowered insulin levels followed by a rise in blood glucose levels back to baseline, which the authors noted may represent normal post-meal alterations in these subjects. Carlson and Shah concluded: "The present results, showing no effect of aspartame or its constituent amino acids on serum glucose or insulin in normal subjects, confirm and extend several previous reports demonstrating no change in these measures in diabetic and normal subjects after oral administration of aspartame." They added, "These findings confirm in humans the previously reported lack of endocrine disturbance in rats given aspartame."

In the second study, conducted by Horwitz et al. (1988), the effects of low-calorie sweeteners on blood glucose and insulin levels were measured in 12 normal subjects and 10 subjects with non-insulin-dependent diabetes mellitus. Subjects were given one of three fruit-flavored drinks at weekly intervals: one unsweetened, one sweetened with 400 mg of aspartame, and one sweetened with 135 mg of saccharin. The aspartame and saccharin drinks were comparable in sweetness and contained approximately the same amount of sweetener found in one liter of a sugar-free soft drink. Fasting blood glucose and insulin levels were measured before and for three hours following the test. The researchers found no significant effect on glucose levels at any time in either the normal or diabetic group. For insulin values, the only treatment effect was in normal subjects 15 minutes following the aspartame test, when insulin levels rose slightly relative to values found after the saccharin-sweetened or the unsweetened beverages.

The authors noted: "The magnitude of (this) difference was small and unlikely to be of physiological importance in the absence of differences in glucose levels." The researchers concluded, "[I]ngestion of aspartame- or saccharin-sweetened beverages by fasting subjects, with or without diabetes, did not affect blood glucose homeostasis."

Härtel et al. (1993) examined five test solutions (one each containing aspartame, acesulfame potassium, cyclamate, saccharin or sucrose) and water in a multiple crossover study. Sucrose resulted in a significant increase in plasma insulin and blood glucose concentrations compared to the low-calorie sweeteners and water. Generally, glucose concentrations were within the normal range, and there were no significant differences in plasma insulin or blood glucose concentrations with the four low-calorie sweeteners compared to water. The authors concluded that there is no cephalic insulin secretion with low-calorie sweeteners.

Teff et al. conducted a randomized study using one and three minute oral exposures in random order to solutions of aspartame, saccharin, and sucrose and water, which were expectorated. Apple pie was used as a modified sham-feed condition. There were no significant increases in plasma insulin concentrations after any of the sweetened solutions, but the apple pie resulted in significant increases in plasma insulin concentrations after both the one and three minute exposures. The taste of sweetened solutions alone, therefore, did not stimulate cephalic-phase insulin release.

Abdallah et al. (1997) conducted a randomized, double-blind, placebo-controlled study to evaluate cephalic-phase insulin release with oral exposure (sucking on the tongue) to three different tablets, tablets containing 3 g of sucrose, 18 mg of aspartame plus 3 g of polydextrose (a non-sweet carbohydrate), or 3 g of polydextrose as a placebo. Plasma glucose, insulin, and glucagon concentrations were not changed after aspartame or sucrose tablets, suggesting that sweet taste alone was not sufficient for eliciting cephalic-phase insulin release.

In sum, the results of these studies demonstrate no cephalic-phase insulin release induced by low-calorie sweeteners. In addition, numerous studies demonstrate that the consumption of low-calorie sweeteners can significantly reduce -- not increase -- caloric intake.

Epidemiology

Epidemiological research also has investigated the benefits of low-calorie sweeteners for weight control. Stellman and Garfinkel (1986) noted the effect of low-calorie sweeteners on self-reported, one-year weight change in a select sub-sample of women enrolled in a prospective mortality study. Analysis was confined to white women aged 50 to 69 with no history of diabetes, heart disease or cancer, and no major change in diet in the past 10 years. According to some media reports, the results showed that use of low-calorie sweeteners may lead to weight gain. The researchers concluded that the study's long-term users of low-calorie sweeteners were more likely to gain weight than non-users (an average difference of less than two pounds) and that the rate of weight gain among users was significantly greater than in non-users. In contrast, the researchers found that among the most obese group, more users than non-users lost at least 10 pounds. Also, they left unexplained the finding that low-calorie sweetener users in the two heaviest weight groups lost more weight than non-users. Interestingly, the authors themselves have noted that artificial sweetener users who lost weight or whose weight did not increase could have gained weight had they not consumed the sweeteners (Stellman and Garfinkel, 1988).

Lavin et al. (1994) have criticized this study for both methodological flaws in experimental design and statistical analysis. Review of this research discloses flaws in the methodology of the study, which raise serious questions concerning the reported interpretations with respect to weight gain. First of all, the study was designed to investigate cancer incidence, not obesity. Also, the researchers themselves recognized that "a beneficial effect, if one exists," might best be demonstrated among short-term users of low-calorie sweeteners or among persons whose low-calorie sweetener consumption is coupled with major changes in dietary behavior -- "groups deliberately excluded from our analysis." Exercise also was excluded from the analysis. By excluding women with major changes in diet and/or a significant level of exercise, the researchers appear to have made the assumption that mere consumption of low-calorie sweeteners will guarantee weight loss or prevent weight gain.

In addition, the subjects' actual consumption of low-calorie sweeteners, as well as their reported current weight and weight one year prior to the study, were not clinically measured but were based on self-reported questionnaires. Stellman and Garfinkel (1988) acknowledged the difficulty of conducting well-controlled efficacy studies, and commented that the high cost of this type of research makes future large-scale clinical efficacy studies unlikely.

In the 1950s, prior to the widespread popularity of low-calorie sweeteners, McCann et al. (1956) studied 247 obese individuals who had participated in weight reduction programs, as well as 100 diabetic patients. In a three-year follow-up study, the obese individuals were questioned about their use of low-calorie sweeteners. Based on the questionnaires, the researchers found no significant difference in weight loss between users and non-users in either the obese or diabetic groups. They noted, however, "it is well to remember that it is the individual who is losing weight, not the group." They added, "(T)he use of non-calorie sweeteners may have a place in the diets of some obese individuals."

Parham and Parham (1980) conducted a smaller observational study investigating the physiological benefits of low-calorie sweeteners. The researchers investigated the effect of saccharin use on sugar consumption in college students and found that use of saccharin resulted in reduced caloric intake. The researchers concluded that, using the criteria of lowered sugar or calorie intake, "saccharin is mildly beneficial to healthy consumers who are watching their weight or trying to limit their sugar intake for other reasons."

Researchers Smith and Heybach (1988) compared aspartame consumption patterns and caloric intakes of 1500 women, utilizing data from a USDA food and nutrition survey. Twenty-five percent of the women questioned had consumed aspartame on the survey day. The mean caloric intake for aspartame users was a significant 165 calories/day less than for non-users; for women aged 35-50 the difference was 215 calories.

Animal Research

The effects of low-calorie sweetener consumption on short-term caloric intake also has been studied in animals. Animal research conducted by Tordoff and Friedman (1989; 1989a; 1989b; 1989c) investigated the hypothesis that consumption of saccharin may hamper attempts to restrict food intake. In the study, rats reportedly were given either a glucose solution, saccharin solution or nothing, followed by a paired flavored food. The rats were found to prefer food paired with a sweet drink regardless of the sweetener used. Rats consuming saccharin reportedly increased their short-term food intake (compared to a maintenance diet), while those consuming glucose did not significantly alter calorie consumption. No long-term effects were observed.

Tordoff and Friedman have noted that a component of the increased food intake in rats consuming saccharin is a learned response. They have offered an additional explanation for their findings, stating that the increase in feeding might be explained as a balancing of solid intake and fluid intake by the rats consuming saccharin. While these are interesting hypotheses, of significance is the fact that the rats given saccharin did not demonstrate any long-term effects, i.e., they did not gain weight.

Research conducted by Porikos in rats contradicts claims that low-calorie sweeteners are ineffective for weight control. In addition, Porikos' animal research confirms her clinical findings that low-calorie sweeteners are effective in helping reduce calorie intake (Porikos and Pi-Sunyer, 1984; Porikos and Koopmans, 1988). Her research in rats found that long-term covert calorie dilution with aspartame and saccharin led to weight loss (Porikos and Koopmans, 1988). In this study, 81 rats were studied for the effects of the consumption of sucrose versus aspartame and saccharin on body weight. The control group received a standard diet of laboratory chow and water. A second group received ad libitum access to an eleven percent sucrose solution, and a third group received a comparably sweet solution of aspartame and saccharin. After eight weeks of the 16-week study, half of the animals in the sucrose and low-calorie sweetener groups were given the other sweetened beverage.

The results showed that the rats ingesting aspartame and saccharin for the full 16 weeks weighed the same as the controls at the end of the experiment, while those consuming the sucrose solution weighed 26 percent more than the rats consuming low-calorie sweeteners. Rats that switched from sucrose to low-calorie sweeteners lost a significant amount of weight compared to rats that kept consuming sucrose. Those that switched from low-calorie sweeteners to sucrose showed a weight gain of 24 percent. Dr. Porikos concluded, "The results show that substitution of artificial sweeteners for sugars prevents weight gain and promotes weight loss in rats."

Conclusions

Low-calorie sweeteners and the products containing them provide sweetness and "good taste" without the calories of their full calorie counterparts. The studies discussed above demonstrate that when sucrose is covertly replaced by low-calorie sweeteners non-dieting obese and normal weight individual incompletely compensate for the calorie reduction. In other words, they consume fewer calories.

Numerous studies have demonstrated that low-calorie sweeteners do not increase hunger, appetite or food intake. Further, multidisciplinary weight control programs that include the use of reduced-calorie foods and beverages sweetened with low-calorie sweeteners may facilitate weight loss and weight maintenance.

The use of low-calorie sweeteners in place of sugar can result in products significantly reduced in calories when compared with their traditional counterparts. In light of the current obesity epidemic, it is important that consumers have available a wide variety of good tasting, reduced-calorie products as tools to assist to them in addressing their calorie goals.

Also of interest, recent research (Sigman-Grant, 2004) was undertaken to determine the impact of reduced calorie foods and beverages (i.e., products sweetened with low-calorie sweeteners) on the micro- and macronutrient composition of the diets of American adults (20 years old and older) who provided two days of dietary recall. The data was the combined 1994-96 Continuing Survey of Food Intakes by Individuals (n=9323) and the accompanying Diet, Health and Knowledge Survey (n=5649). Reduced calorie product users reported consuming significantly less total and saturated fat, cholesterol, energy, and added sugars, while having significantly higher intakes of vitamins (e.g., vitamins A, E, and folate) and minerals (e.g., calcium, iron and zinc) from their foods. These users also reported consuming higher amounts of dark green and yellow vegetables.

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