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Artificial Sweeteners, Diabetic Foods & Supplements Myths & Facts [A Meta Analysis]

KEYWORDS: Artificial sweetener, Non-nutritive sweetener, Diabetic food supplements, Aspartame, Cyclamate

DR. MRITUNJAY KUMAR AZAD
M.B.B.S., D.T.M&H., M.D., TUTOR, DEPARTMENT OF PHYSIOLOGY, J.L.N.MEDICAL COLLEGE, BHAGALPUR, BIHAR,

DR. SWETA GUPTA
J. R. 2 DEPATMENT OF MICROBIOLOGY,D.M.C. DARBHANGA, BIHAR,

ABSTRACT *Recent epidemiological, clinical and laboratory findings question whether recommendations for the use of artificial sweeteners are indeed appropriate. Through this study, consumers make well-informed decisions about their health. In this review, we examined the existing evidence supporting or refuting a link between artificial sweetener use, diabetic food intake and weight change and other metabolic effects. Use of NNS in absence of dietary restrictions and exercise will not help in weight reduction. Reduction of body weight can be effected only when there is a energy deficit in body, which can only be achieved by reduction in total intake of calories.*

Introduction

Type 2 Diabetes mellitus is growing at an alarming rate world wide with around 366 million diabetics worldwide. It can be controlled to a large extent by healthy diet and exercise. An ideal diet for diabetics contains; (1) Low-calorie, low-sugars/processed foods, (2) Adequate proteins, vitamins and minerals. Consumption of artificial sweeteners and diabetic foods is increasing, so, as to control diabetes, reduction of calorie intake is also necessary. Consumption of food supplements is also increasing. Macro and micronutrients is also needed for the ideal diet.

Artificial sweeteners & Diabetic foods

Artificial sweeteners or non-nutritive sweeteners (NNS) are defined as, substances with a higher degree of sweetness per gram as compared to caloric sweeteners (e.g; sucrose, corn syrups, fruit juice concentrates). NNS are used in only small quantities for replacement hence provide few or nil calories. The consumption of NNSs is increasing at an alarming rate. In 2003–2004, 15% of Americans consumed NNSs as compared with 3% in 1965. Till date, 6 NNSs have been approved by US-FDA of which 5 are artificially prepared. Diabetic foods generally use NNS, in place of sugar, marketed targeting the diabetic population.

Non-nutritive sweeteners (NNS)

Aspartame: Most widely used and most controversial NNS. It is associated with side effects such as nausea, vomiting, headache especially migraine, and dry mouth. The potential harmful effects after long-term consumption of aspartame can cause hepatocellular injury, alter the hepatic antioxidant balance and changed behavior in rats. Aspartame present in beverage cans when stored at high temperatures and at pH >6, can break into its metabolite diketopiperazine which is a CNS carcinogen. Aspartame was initially banned by FDA, but later revoked the ban.

	kcal/g	Commercial name	Relative sweetness (compared to sugar)	Acceptable Daily Intake (mg/kg BW)	Average amount in 1 sachet (mg)	Average amount in 12 fz of diet soda (mg)	Other info
Saccharin	0	Sweet 'N Low	200-700x	5	42	8	Heat stable, bitter after taste
Aspartame	4	NutraSweet, Equal	160-220x	50	14	187	Heat sensitive, no aftertaste
Acesulfame K	0	Sweet One	250x	15	40	40	Synergystic sweetening property
Sucralose	0	Splenda	600x	5	48	48	Heat and pH stable
Cyclamate	0	Magic Sugar	30-80x	11	-	-	Not available to consumers
Stevia	0	Stevia	100-150x	4	17	17	Heat stable, pleasant aftertaste

Table: Nonnutritive sweeteners

Acesulfame potassium(ACE-K): Its potential toxicities include nausea, headache, mental confusion, depression, loss of appetite, etc **Cyclamate:** Was banned in 1960s due to carcinogenicity and fetal developmental retardation in rats. It also affects pancreas and testes in rats. In 1984, FDA concluded that it was noncarcinogenic when used in humans and revoked the ban. Humans convert cyclamate into cyclohexylamine which is a toxic metabolite over long-term consumption.It is not available in India **Neotame:** It is most recent NNS. It has highest sweetness amongst NNS. It is Non-caloric and Non-toxic in studies so far.

Saccharin: Initially banned, based on studies showing carcinogenicity in rats. Studies have reported hepatotoxicity associated with its use. **Sucralose:** Associated with migraine and involution of thymus. Sucralose also associated with DNA damage in gastrointestinal organs, hepatotoxicity, nephrotoxicity, fetal and placental developmental retardation.

Volume : 6 | Issue : 12 | December 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 79.96

Stevia: The only natural NNS available, extracted from plant *Stevia rebaudiana,* without any chemical modification not found to have any carcinogenic, genotoxic, developmental and reproductive side effects. **NNSs in diet:** NNS can be intentionally added to diet by diabetics as a substitute for sugar. A large amount is unknowingly consumed through beverages and soft drinks. 4-18% soft drinks consumed by us are artificially sweetened. Diabetic foods are sweetened with NNS with diabetics as targets in their marketing strategy. Studies have observed that and increase in consumption of artificially sweetened food is not associated reduced caloric intake, in comparison with, consumption of foods sweetened by caloric sweeteners. Thus the net effect of using NNS is nullified.

Benefits of NNSs: NNSs have definite advantages over caloric sweeteners. NNSs do not increase appetite. Foods and beverages sweetened by NNSs reduce energy intake as compared to energy dense foods. NNSs cause modest weight loss along with a reduction in fat mass and waist circumference. NNSs have beneficial effects on postprandial glucose and insulin in healthy individuals and diabetics. NNSs are not fermented in the oral cavity by the bacteria and reduce the rate of teeth demineralization.

NNS myths: NNS are OHAs or anti-obesity drugs. NNS are not pharmaceutically active substances. They only provide sweet taste with a much lower calorie content. They cannot be used in treatment of diabetes or obesity. NNSs can reduce body weight without dietary and lifestyle modifications. NNSs can result in infertility, fetotoxicity, CV events and carcinoma.

Though many of the NNS were initially thought to cause above effects in animal studies and hence humans. Later studies have showed their use to be safe in humans. Long term data however is lacking that, NNSs have abuse potential. NNS have no psychotropic effects and hence do not have addictive or abusive potential. NNSs have no upper safe limit of consumption. **Acceptable daily intake** (ADI) can be defined as the amount of NNS (mg/kg body weight) that is considered to be safe to consume every day for a life time. Usually, ADI is 100 times lower than the sweetener dose that caused toxicity in animal studies.

NNS Facts: Use of NNS in absence of dietary restrictions and exercise will not help in weight reduction. Reduction of body weight can be effected only when there is a energy deficit in body, which can only be achieved by reduction in total intake of calories.

According to American academy of pediatrics, (2010), health benefits of NNSs are inadequately assessed in children hence they should not form a significant part of a child's diet. Indian guidelines, (2011) suggests, NNSs could be used in moderate amounts. There are no nutrient benefits to NNS consumption and long-term safety data for NNS are inadequate. Academy of nutrition and dietetics (2012). NNSs approved by the US-FDA are safe when taken as per federal nutritional

Recommendations. NNSs help to reduce dental caries.

Diabetic food supplements

Dietary supplements are food products, extracts or concentrates that are intended to supplement diets. It contain certain dietary ingredients such as vitamins, minerals, herbs, and amino acids. They are found in many forms, Tablet, capsule, powder, liquid, bar, soft-gel and gel-cap. Diabetic foods supplements have found wide acceptance among diabetics, believed to be foods rather than drugs, perceived to be free from side effects;

Alpha-lipoic acid: Found in liver, spinach, broccoli and potato.

Acts on nerve cells, kidneys and liver to prevents cell damage and improve the body's ability to use insulin. But it may cause hypoglycemia.

Chromium: Trace element found in meat, whole grain products, fruits, vegetables and spices. Chromium keeps pancreas working well and lowers blood sugar levels. High doses of chromium can cause kidney problems.

Omega- 3 fatty acids: Poly unsaturated fatty acids found in vegetable oil (canola and soybean) walnuts, and wheat germ. It act on liver and heart and maintain blood glucose levels. Omega-3 fatty acids are safer at low-moderate doses May interfere with certain medications at higher doses.

Polyphenols: Found in green tea and dark chocolate, cause relaxation of vascular tissue, lower blood glucose levels by enhancing insulin action, contain caffeine which can cause insomnia, anxiety and irritability.

Green tea: also has small amounts of vitamin K which can interfere with anticoagulant drugs like warfarin.

Magnesium: Found in fat or fiber from fruits, vegetables, grains and cereals. Acts on kidneys, hearts and muscle. Magnesium Improves blood glucose levels and insulin response but can cause loose stools in sensitive individuals.

Coenzyme Q10: Present in vitamin B, fatty fish, meats, peanuts and spinach Improves long-term gycemic control in type 2 diabetics. Body stores of Co-Q10 can be reduced when used along with certain diabetic medications like glyburide. **Folic acid:** Found in spinach, broccoli, avocado, oranges, tomatoes and bananas. Prevents strokes and diabetic neuropathy. High doses of folic acid can cause neural damage .

Selenium: Found in broccoli, radish, cabbage, onion, garlic, cereals, meats, mushrooms, fish, nuts and eggs. Helps intake of blood sugar into the cells.Protects blood vessels and nerves from damage due to hyperglycemia. Low blood selenium predisposes to cancers, coronary heart disease and diabetes.

Vitamin B6 (pyridoxine): Found in bran, brown rice, oats, molasses, wheat germ, banana, plum, fish and salmon. Helps prevent diabetic retinopathy. Excess of vitamin B6 can produce painful dermatological lesions.

Vitamin C: Present in fruits and vegetables. Improve glucose metabolism. **Vitamin E:** Found in vegetable oils, nuts, whole grains, avocado, carrots, peanuts, almond, hazelnuts. Improves glucose utilization by the cells. Large doses of α-tocopherol are known to deplete plasma and tissue γ-tocopherol. **Zinc:** Assists in production, storage and secretion of insulin. High doses may cause nausea, vomitng, headache and drowsiness.

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Copper: Found in oats, bran, apples and almond. Prevents hyperglycemia induced damage to blood vessels and nerves. Protects pancreatic cells and lowers blood sugar levels.

Diabetic food supplements: Myths
Diabetic food and supplements are free of side effects. Some supplements may cause allergic reactions, competitive inhibition for absorption of other nutrients and drug-nutrient interactions. Diabetic supplements are safe once approved by FDA. Most of the dietary supplements do not undergo the same stringent regulatory approval process as drugs. Demonstration of safety and efficacy not mandatory to support legal marketing of dietary supplements. Diabetic supplements can be used to treat diabetes. Few clinical trial reports are available to support the use of herbal and botanical supplements in the prevention or treatment of high blood pressure or diabetes. No large scale trials have established their efficacy as therapeutic agents.

Diabetic food supplements: Facts
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Few clinical trial reports are available to support the use of herbal and botanical supplements in the prevention or treatment of high blood pressure or diabetes. No large scale trials have established their efficacy as therapeutic agents. Inadequate nutritional intake of essential vitamins and minerals may worsen diabetes and its complications. Additional nutrients from supplements can help patients meet their medical needs and requirements.

Discussion
Recent epidemiological, clinical and laboratory findings question whether recommendations for the use of artificial sweeteners are indeed appropriate. A careful review of this literature by health professionals including physicians, epidemiologists, and dietitians is necessary to help consumers make well-informed decisions about their health. In this review, we have examined the existing evidence supporting or refuting a link between artificial sweetener use and weight change and other metabolic effects.

Epidemiologic studies of artificial sweetener use have generally shown a positive association between artificial sweetener intake (most commonly as diet soda) and weight gain. In interpreting such studies, it is critical to consider the conditions required to support causality in such studies, including the strength of the association, consistency in findings, temporality, biological gradient, plausibility, coherence between epidemiological and laboratory findings, and strength of the dose-response relationship. Based on these criteria, causality is far from established with regard to artificial sweetener use and weight gain in children. It is particularly difficult to establish causality between artificial sweetener consumption, weight gain, and metabolic abnormalities, as artificial sweetener intake is likely to be an indicator for other variables. For example, the decision to consume artificial sweeteners is often made by individuals who are concerned about their weight in an effort to reduce their caloric intake.

Although not all studies agree, the general trend is that artificial sweeteners may reduce total caloric intake when consumed between meals, but when consumed with meals, Such studies, while not realistically mimicking actual human behavior, may provide insight into underlying mechanisms.

The strongest evidence for causation between artificial sweetener use and either adverse or beneficial health effects comes from randomized controlled trials. The few small, randomized controlled trials conducted in children did not find an association between artificial sweetener consumption and weight change. However, these studies were not specifically designed to look for effects of artificial sweeteners on weight change, and were presumably underpowered to find such effects. Currently, several trials are in progress to study the effects of artificially-sweetened carbonated soft drinks on body weight and other metabolic parameters in both children and adults, and studies of mechanisms underlying metabolic effects of artificial sweeteners are ongoing as well. These studies, and other similar investigations, will be critical for advancing understanding of the role of artificial sweeteners in metabolic health.

Conclusions
Artificial sweeteners and diabetic supplements have been gaining interest of consumers over the years. Awareness of these products is needed to remove myths which exist regarding their use. These products when used in a prescribed manner can help in controlling diabetes. However , they are not a substitute for a healthy diet and physical exercise in controlling diabetes. Additional nutrients from supplements can help patients meet their medical needs and requirements. More studies are needed to ascertain the safety and efficacy of these products.

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Volume : 6 | Issue : 12 | December 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 79.96

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