# Low Calorie / Non Nutritive Sweeteners: Safety And Benefits

International Life Sciences Institute-India

# PREFACE

With as many as 347 million people worldwide suffering from diabetes and over 200 million men and nearly 300 million women being obese the demand for natural and low calorie sweeteners has increased dramatically among health conscious consumers who prefer alternatives to traditional sugar, sucrose (WHO Report, 2014). India has also gone through such drastic changes in last 2-3 decades because of economic betterment. This demographic and epidemiologic transition has meant a shiftfrom infectious disease to non-communicable diseases (NCDs) such as Obesity, Diabetes, Chronic Heart Disease (CHD), PCOS/MS, Hypertension, Stroke, Many Cancers, Chronic Lung Disease etc. as the primary causes of mortality. The risk factors responsible for NCDs are: genetic predisposition,diet, sedentary lifestyle, stress,smoking, pollution, automobiles, aging population and urbanization.

The diets consumed by Indians are predominantly cereal based vegetarian diets. The protein is not adequate and generally comes from pulses and milk products. The Indian diets are rich in carbohydrates and fats. Current per capita consumption of sugar in India at 20.2 kgs is low compared to global per capita consumption of 24.8 kgs. However, its consumption is increasing at a fast pace and in last 50 years India's share in global consumption has gone up from 5% to 13%. Public health attention has therefore, turned to reversing the obesity epidemic in individuals of all ages by choosing to use products containing low calorie non-nutritive sweeteners which provide sweet taste to foods without associated high energy content of caloric sugars.

The use of low calories sugar free products have tripled world over in the last two decades. Comparatively in India their use in foods and beverages may be only slightly more than a decade old.

This monograph provides detailed information about sugars, low calorie non-nutritive sweeteners and their safety and how they can act as an aid in weight reduction and maintenance and controlling diabetes. References are provided in the end for deeper study. We hope that the readers will find this Monograph useful and interesting and that it will serve as a valuable reference tool.

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# Section 1: Sugar As A Sweetener

Sweetness is a perception. It is one of the five primary sensations and probably the most beloved sensation of all, due to its intensity. Sweeteners provide sweet flavor when added to food; maintain freshness and product quality; act as preservatives and as flavor enhancers.

Sugar (sucrose) commonly known as **Table sugar** is a carbohydrate which plays a major role in providing energy for regulating various cellular and metabolic functions in living organisms. These are amongst the three prominent macronutrient that serve as excellent energy providers, while the other two are fats and proteins. Sucrose is an organic compound, which is white, colorless and crystalline in nature, with the general formula of C12H22O11. One molecule of sucrose is composed of one molecule each of D- glucose and D- fructose that are linked together by a bond known as a glycosidic linkage (Fig 1.).

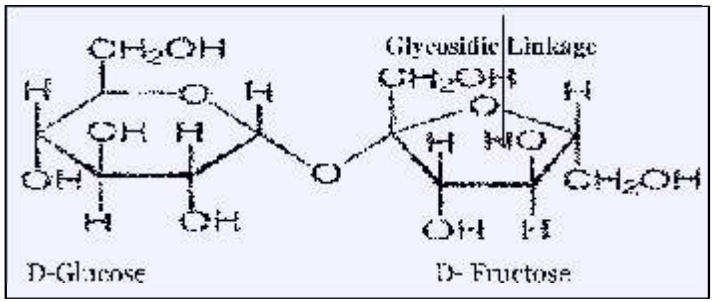


**Fig 1. Structure of Sucrose (Table Sugar)**

Sucrose is found to naturally occur in sugarcane (*Saccharum* spp.), sugar beets (Beta vulgaris), honey and corn syrup. About 80% of the world's sugar is produced from sugar cane, which is grown in tropical countries, while the remaining 20% is produced from sugar beet, which is cultivated in the temperate regions of the northern hemisphere. The chief producer of sugar in the world is Brazil, accounting for approximately 22% of the world production. In India, the major sugar producing states are Andhra Pradesh, Bihar, Gujarat, Haryana and Karnataka. Sucrose (table sugar)

plays a key role in the food industry as it is a major component in food preservatives and in confectionaries. It improves the palatability of many foods and thereby encourages a more varied diet. Sugar gives instantaneous feeling of well-being, happiness and also releases stress.

Table sugar is relatively cheaper and therefore used abundantly in confectionaries which are readily available to the consumers. This has also resulted in over consumption of sugar, which according to public perception leads to dental caries &obesity that may be associated with Type 2 diabetes, hypertension, hypertriglyceridemia, heart diseases and dental caries (Department of Health, UK). However, it is scientifically incorrect to consider sugar as the only factor leading to NCDs. . The consumption of total carbohydrates and lack of physical activity along with other lifestyle factors are the key contributors to these problems. It is well known that preferences for sweets remain with people throughout their lives. It is difficult to remove sweet taste from diets of people even though they may be suffering from diabetes or are required to lose weight. Nevertheless, it is vital to consume sugar in moderation. It should not exceed more than 10% of total calorie intake.

Sugar substitutes offer a safe option for enjoying sweet taste without calories. They are completely safe for human consumption with no adverse effect on health.

# Section 2: What Are Low Calorie / Non Nutritive Sweeteners?

Low calorie sweeteners are substances added to foods and drinks to provide sweet taste without calories, or with very few calories. Most low calorie sweeteners are several hundred times sweeter than table sugar, meaning that only small quantities need to be added to achieve a sweetening effect.

Low calorie sweeteners have been safely used and enjoyed by consumers all over the world for more than a century. These sweeteners are sugar free products added to foods and beverages to provide sweetness without increasing the blood glucose level. These sweeteners are generally having zero or very low caloric value. The first commonly used low calorie sweetener, saccharin, was discovered in 1879. Since then, a number of other low calorie sweeteners, including acesulfame K (ace-K), aspartame, cyclamate, sucralose and many others have been discovered and are now in widespread use worldwide.

**Low calorie sweeteners are used in a variety of food and drink products including:**

- Soft drinks
- Milk based beverages
- Chewing gum
- Confectionery
- Bakery products
- Frozen desserts
- Yoghurts
- Dessert mixes
- Puddings
- Indian sweets

Low calorie non –nutritive sweeteners are also widely used in healthcare, making many medicines more palatable. Low calorie sweeteners are clearly labeled on the packages of food, beverages healthcare products that contain them. These sweeteners play an important role in achieving and maintaining an active, healthy lifestyle as also in weight maintenance, weight reduction, management of diabetes, reduction of dental caries, and reduction in the risks associated with obesity. Low calorie sweeteners enable us to increase the palatability of healthy and low calorie foods and to enjoy the same level of sweetness as with products containing sugar, without the equivalent calories. If used consistently to reduce calories, they can act as an aid to weight reduction, weight maintenance and oral health. Furthermore, as low calorie sweeteners do not affect insulin levels, they may be used to provide sweet-tasting foods and drinks for people who must carefully monitor carbohydrate intake, such as those with diabetes.

Health professionals believe that low-calorie sweeteners provide both psychological and physiological benefits to consumers.Low- and no-calorie sweeteners offer consumers options to help them with their lifestyle — whether to help with energy balance and support a healthy weight, manage a diabetic diet or simply provide a sweet taste without adding calories. A 2013 study examined data from more than 22,000 people who participated in the U.S. National Health and Nutrition Examination Survey (NHANES) and found that people who consumed foods and beverages with no- and low-calorie sweeteners had better quality diets and were more physically active. The study supported earlier findings by Sigman-Grant and Hsieh (2005) that suggested people who regularly use low- and no-calorie sweeteners may choose healthier diets. In 2014, a group of leading international independent experts in the fields of nutrition, epidemiology, psychology, dentistry, weight management, obesity prevention and treatment and diabetes collaborated on a review of the current evidence on the benefits of low-calorie sweeteners. Their key findings were published in a consensus statement in Nutrition Bulletin. Their conclusions affirmed the beneficial role that low calorie sweeteners can play in diet and lifestyle choices.

**Key findings included:**

- Low-calorie sweeteners do not increase appetite and have no discernible effect on satiety.
- Low-calorie sweeteners help to reduce energy when used in place of higher energy ingredients.
- Low-calorie sweeteners can enhance weight loss under real-life conditions when used as part of a behavioral weight-loss program.
- Low-calorie sweeteners may have a beneficial effect on post-prandial glucose and insulin in healthy individuals and in people with diabetes.
- Low-calorie sweeteners have dental benefits when used in food, beverages, toothpaste and medications, provided other constituents are also non-cariogenic and non-erosive.

Low calorie sweeteners are ingredients that are many times sweeter than sugar (sucrose). Examples include acesulfame-K, aspartame, saccharin, stevia and sucralose which are between 150 and 600 times sweeter than sucrose, and neotame which is between 7,000 and 13,000 times sweeter (Table below). The sweetness intensity of low calorie sweeteners depends on their inherent sweetening power and the concentration at which they are used.

The calorie content varies from zero to 4 kilocalories per gram, but all deliver very few calories in practice because they are added to products in only tiny amounts. Low calorie sweeteners are typically found in soft drinks, desserts, dairy products, confectionery, chewing gums and hot chocolate drinks. Most are also available as table top sweeteners, which are used in tea and coffee or in other foods, such as fruit and breakfast cereals.

## Table 1. Examples Of Low Calorie Sweeteners

| | Approximate sweetness(sucrose =1) |
|---|---|
| Lactitol | 0.4 |
| Hydrogenated starch | 0.4-0.9 |
| Trehalose | 0.45 |
| Isomalt | 0.45-0.65 |
| Isomaltulose | 0.48 |
| Sorbitol | 0.6 |
| Erythritol | 0.7 |
| Mannitol | 0.7 |
| Maltitol | 0.9 |
| D-Tagatose | 0.9 |
| Xylitol | 1.0 |
| High Fructose corn syrup, 55% | 1.0 |
| High fructose corn syrup, 90% | 1.0 |
| Crystalline fructose | 1.2-1.7 |
| Cyclamate | 30 |
| Glycyrrihizin | 50-100 |
| Aspartame | 180 |
| Acesulfame potassium | 200 |
| Saccharin | 300 |
| Stevioside | 300 |
| Sucralose | 600 |
| Heranmanduclin | 1000 |
| Monellin | 1500-2000 |
| Neohesperidinedihydrochalcone | 1800 |
| Alitame | 2000 |
| Thaumatin | 2000-3000 |
| Neotame | 8000 |

Source: Alternative Sweeteners (Lyn O'Brien Nabors, 2001)

Low calorie sweeteners have been available for more than a century. Saccharin was used extensively during sugar shortages, e.g. during World War I. Although in some countries after 1945 soft drinks were sweetened with combinations of sucrose and Saccharin, diet and light beverages did not become popular until the early 1980s when Aspartame was introduced. Over the past three decades, consumptionof low calorie soft drinks in Europe have risen more than 15 fold.

Low calorie sweeteners are used in a broad variety of foods and drinks for a number of reasons, including consumers' interest in controlling their weight and efforts by manufacturers to offer a choice of calorie levels in their products. The improved palatability of low calorie sweeteners is another reason. Whereas early sweeteners had some taste challenges, particularly when used as a unique sweetener in a product, the introduction of newer low calorie sweeteners improved taste profiles. Blends of sweeteners are also used because they often have a higher level of sweetness than would be expected from the amount of the individual sweeteners that are present: the whole is greater than the sum of the parts.

In addition to low calorie sweeteners, polyols are used in confectionery, chewing gum and desserts. Polyols, such as maltitol, isomalt, sorbitol, mannitol and xylitol provide about 2.4 kilocalories per gram (8.4 kJ/g) as opposed to the 4 kilocalories per gram (16.8 kJ/g) found in dietary sugars and carbohydrates. The exception is erythritol, a zero calorie bulk sweetener approved in Europe in 2006.2 The role of polyols in products is not just to replace sweetness but to take over many of the functional properties provided by sugars, including mouth feel, colour, structure, and moisture retention properties.

# Section 3: How Safety Is Ensured

Food ingredients are evaluated and/or regulated by numerous national and international bodies. International groups include the Joint Food and Agriculture Organization/World health Organization Expert Committee on Food Additives (JECFA), the Codex Alimentarius Commission, and Scientific Committee for Food of the Commission of European Union.

The objective of the joint Food and Agriculture Organization/World Health Organization (FAO/WHO) program on food additives is to make systematic evaluations of food additives and provide advice to member states of FAO and WHO on the control of additives and related health aspects. The two groups responsible for implementing the program are JECFA and the Committee on Food Additives of the Joint FAO/WHO Codex Alimentarius Commission.

JECFA is made up of an international group of experts who serve without remuneration in their personal capacities rather than as representatives of their governments or other bodies. Members are selected primarily for their ability and technical experience ,with consideration given to adequate geographical distribution .Their reports contain the collective views of the group and do not necessarily represents the decision or the state policy of WHO or FAO. The experts convene to give advice on technical and scientific matters ,establishing specifications for identity and purity for food additives, evaluating the toxicological data, and recommending, where appropriate, acceptable daily intakes for humans. The Expert committee also acts in an advisory capacity for the Codex Committee on Food Additives and Contaminants.

The Codex Alimentarius Commission was established in 1962 to implement the Joint FAO/WHO Food Standards Program. Membership is made up of those member nations and associate members of FAO and WHO that have notified the Director-General of FAO or WHO of their wish to be members. The stated purpose of the program is:

“To protect the health of consumers and to ensure fair practices of the food-trade: to promote coordination of all food standards work undertaken by international governmental and

non-governmental organizations: to determine priorities and initiate and guide the preparation of draft standards through and with the aid of appropriate organizations: to finalize standards and after acceptance by governments publish them in a Codex Alimentarius either as regional or worldwide standards."

The Codex Committee for Food Additives and Contaminants (CCFAC) is the body that deals with food additives.

The World Trade Organization (WTO) encourages countries to harmonize food standards on the basis of Codex standards and uses its decisions to settle trade disputes. In addition, the WTO recognizes JECFA specifications for food additives in international trade, increasing the importance of both Codex and JECFA.

The scientific Committee for food (SCF) of the Commission of the European Union was established by the Commission in 1974. The Committee advises the Commission "on any problem relating to the protection of the health and safety of persons arising from the consumption of food, and in particular the composition of food, processes which are liable to modify food, the use of food additives and other processing aids as well as the presence of contaminants." Committee members are independent persons qualified in medicine, nutrition, toxicology, biology, chemistry, or other similar disciplines. Committee opinions are submitted to the Commission.

Currently, the European Union (EU) has approved a list of food additives permitted for use in foods and drinks (European Commission 2008, 2011), including conditions of use, which contained acesulfame-K (E-950), aspartame (E-951), cyclamate (E-952), saccharin (E-954), sucralose (E-955), neohesperidin dihydrochalcone (E-959, NHDC), neotame (E-961) and advantame (E-969), steviol glycosides (E-960) and thaumatin (E-957).

The Committee on Food Chemicals Codex (FCC), a full committee of the Food and Nutrition Board, Institute of Medicine, National Research Council of the U.S. National Academy of Sciences, provides information on the quality and purity of food-grade substances. Specifications and test methods are included in almost 1000 FCC monographs on substances that are added to or come in contact with foods. The members of the Committee on FCC are chosen for their special competencies and with regard to appropriate balance.

Food Chemicals Codex is recognized internationally. FCC specifications are cited, by reference, in the U.S. Code of Federal Regulations as the reference for specifications to define specific safe ingredients. In Canada, FCC and its supplements are officially recognized in the Canadian Food and Drug Regulations as the reference for specifications for food additives. Under New Zealand for food regulations, a food additive is defined as being of appropriate quality "if it complies with the monograph for that food additive (if any) in the current edition of the Food Chemicals Codex published by the National Academy of Sciences and the National Research Council of the United States of America in Washington. D.C." Similarly the national food authority of Australia frequently refers to the Food Chemicals Codex specifications to define food additives.

## Acceptable Daily Intake

As part of the evaluation of food additive, many regulatory bodies establish an acceptable daily intake (ADI) level. The ADI "for man, expressed on a body weight basis, is the amount of a food additive that can be taken daily in the diet over a lifetime ,without risk". The ADI may be used as benchmark to evaluate the actual intake of a substance and as an aid in reviewing possible additional uses for a food ingredient. The ADI is expressed in milligrams per kilogram of body weight.

The ADI is a conservative estimate that incorporates a considerable safety factor. It is established from toxicological testing in animals, and sometimes humans, and is usually estimated by applying an intentionally conservative safe factor (generally a 100 –fold safety factor). Animals tests are used to determine the maximum dietary level of an additive demonstrating no toxic effects, a "no observable effect level "or NOEL. The NOEL is then used to determine the ADI .For example, if safety evaluation studies of a given substance demonstrate a NOEL of 1000mg/kg, using a 100 fold safety factor the ADI would be 10mg/kg body weight per day for humans.

The ADI does not represent a maximum allowable daily intake level. It should not be regarded as a specific point at which safety ends and possible health concern begins. In fact, the U.S FDA has said it is not concerned about consumption levels occasionally exceeding the ADI .The agency has

stressed that because the ADI has a built in safety margin and is based on a chronic lifetime exposure ,occasional consumption in amounts greater than the ADI "would not cause adverse effects".

## Low Calorie Non-Nutritive Sweeteners

The sweetener market In India today stands at approximately Rs. 1.5 billion with a double digit growth. This is miniscule, looking into the number of diabetics and pre diabetics in India. With the changed regulatory scenario allowing use of sweeteners in everyday consumables the market is bound to grow. With the entry of new and safer molecules, the artificial sweetener industry in India could witness large volumes. Increasing awareness and endorsements by culinary experts and cine personalities would certainly help the Indian diabetic population to opt for alternative sweeteners.

The Government of India's (GOI) Food Safety and Standards Authority of India (FSSAI) amended the Food Safety and Standards (Food Product Standards and Food Additives) Regulations, 2011, related to FSSAI's standards for artificial sweeteners.FSSAI has approved following artificial sweeteners, namely, Saccharin Sodium, Aspartame (methyl ester), AcesulfamePotassium, Sucralose, Neotame, and steviol glycoside,. Recently, Isomaltulose has been added in the list of Artificial Sweeteners in Regulation No. 3.1 of FSS (Food Products Standards & Food Additives) Regulations, 2011. Isomaltulose is allowed to be used in the confectionery products and the maximum limit shall be 50 per cent (max) of total sugar without adversely affecting the stability of the product. Ice Lollies or Edible Ices have been excluded from the state confectionery products category.

The sugar substitutes are thoroughly investigated for safety with hundreds of scientific studies and then approved by different regulatory authorities like the U.S. FDA, JECFA and FSANZ. Some agents are approved with warning labels too. So further exploration is required with well-designed large-scale studies in the general population.

# Section 4. Commonly Available Sweeteners

**Saccharin:** Saccharin is the oldest artificial sweetener (discovered in 1878) and has been used for over 100 yrs. Initial rat experiments showed a tendency for urinary bladder tumors but this was not found to happen in any other species nor were there any human reports. It is about 300 times sweeter than sugar but has sometimes given a bitter after taste. Saccharin has been declared as safe by American Cancer Society, AMA and academy of nutrition dietetics. It is not affected by heat and hence an advantage in baked foods. As per JECFA, ADI is 5 mg/kg of body weight [1].It is approved in more than 100 countries. Allowed by FSSAI in Carbonated water: 100 ppm, chocolates and Indian traditional sweets: 500 ppm, sugar based/sugar-free confectionery and chewing gum/bubble gum; 3000 ppm.

**Cyclamates:** Michael Sveda in 1937 discovered Cyclamte. In 1958, after enactment of the Food Additive Amendment to the Food, Drug, and Cosmetic Act, the Food and Drug Administration (FDA) of the United States classified Cyclamate as a GRAS, or Generally Regarded as Safe sweetener. It refers to three different compounds: Cyclamic Acid, Calcium Cyclamate and Sodium Cyclamate. It is a low calorie sweetener. ADI set by JECFA is 11mg / Kg B wt. It is 30 times sweeter than sucrose. It is used in over 100 countries. It is not approved by the FSSAI.

**Aspartame**: G. D. Searle and James Schlatter in 1965 discovered Aspartame. It is 200 times sweeter than sugar. Presently, Aspartame is used in approximately 6000 different products world wide. The safety of Aspartame has been affirmed by numerous scientific and regulatory bodies, including the Joint FAO/WHO Expert Committee on Food Additives (JECFA) of the Codex Alimentarius, US Food and Drug Adminstration (FDA) and the regulatory agencies of more than 100 other countries around the world. More than 500 studies were reviewed and it was found to be safe in food except in phenylketonurics. Aspartame is allowed and approved by FSSAI in Carbonated water: 700 ppm, non-carbonated water based beverages: 600 ppm, biscuit, bread, cakes: 2200 ppm, Indian sweets: 200 ppm, jams

jellies: 1000 ppm, sugar based/free confectionery: 10000, chocolates: 2000 ppm, ice cream: 1000 ppm, flavored milk: 600 ppm, RTE cereal: 1000 ppm, still beverages: 600 ppm [2].

There is a labeling requirement that it is not recommended for children and in phenylketonurics. It has two amino acids phenylalanine and aspartic acid. It gets hydrolyzed into the two amino acids and a small amount of methanol, which is metabolized and is much less than the amount of methanol generated from other sources. More than 500 studies have been carried out on Aspartame and has been declared safe by all regulations. EFSA permits its use even in pregnant women and children – ADI is 40mg/ Kg B wt.

**Neotame:** It is a new high-intensity sweetener and flavor enhancer it is similar to aspartame about 7000-13000 times sweeter than sugar. There are more than 100 studies establishing its safety. FSSAI has permitted its use in soft drinks at a maximum limit of 33 ppm. ADI according to JECFA is 2 mg/ Kg B wt. This zero calorie sweetener has a clean sweet taste with no undesirable taste characterstics.

**Tagatose or D-Tagatose:** This **is** a low calorie bulk sweetener with 92% of the sweetness of sucrose. Tagatose is a naturally occurring low calorie bulk sweetner. It is a non cariogenic, prebiotic and a good flavor enhancer and has a reduced caloric valuae. D-Tagatose is found in heated cow's milk and occur in various other dairy products. The FDA has approved the use of a factor of 1.5kcal/g for calculating the calorie valuae of tagatose.

**Acesulfame Potassium (ACE-K):** Clauss and Jensenin 1967 discovered Acesulfame K. It is a white, Crystalline powder. **ACE-K**dissolves readly in water. It is 600 times sweeter than sugar. Used in a large variety of foods in over 90 countries. Joint Expert Committee on Food Additives (JECFA) of the WHO and FAO approved for the use in food with the allocation of an ADI of 0-15 mg/kg of body weight. FSSAI allows it in Carbonated water and non-carbonated water based beverages: 300 ppm, biscuits, cakes etc.:1000 ppm, Indian sweets: 500 ppm, sugar based/free confectionery: 3500 ppm, still beverages 300 ppm, ready to serve tea and coffee based beverages: 600 ppm.

**Alitame:** Alitameis a crystalline, odorless, nonhygroscopic powder. It is around 2000 times more sweet than table sugar (sucrose). The sweetness of alitame is of a high quality, sucrose like, without accompanying bitter or metallic notes often typical of high potency sweeteners. The sweetness of Alitame develops rapidly in mouth and lingers slightly, in a manner similar to that of aspartame. Alitame was reviewed by joint Expert Committee on Food Additives (JECFA) of the WHO and FAO in 1995 and approved for use in food and allocated an acceptable daily intake (ADI) on 1 mg/kg of body weight.

**Sucralose:** Sucralose is a high-quality, high-potency, noncaloric sweetener that is derived by the selective chlorination of sucrose. It was discovered in 1976. It is 600 times sweeter than sugar. It is used in a wide variety of foods in over 80 countries. It does not elevate blood glucose levels. ADI is 15 mg/ Kg. There are no reported safety concerns. It is allowed by FSSAI in carbonated water and non-carbonated water based beverages: 300 ppm, biscuits, cakes; 750 ppm, Indian sweets: 750 ppm, still beverages: 300 ppm, jams jellies: 450 ppm, ready to serve tea and coffee based beverages: 600 ppm, ice lollies/ candies: 800 ppm, confectionery: 800 ppm-1500 ppm[2].

**Steviol Glycosides:** It has been approved recently by FSSAI (2015). It was approved by JECFA in 2009. They are natural constituents of the leaves of stevia rebaudiana. They are 200 to 400 times sweeter than sugar. Stevia glycosides- rebaudiside A, Stevioside-Rebaudioside D, Steviol glycoside mixtures with rebaaudiside A and / or stevioside are all sweeteners.

Stevia sweeteners are approved as table top sweetener and for addition to food and beverages in approximately 49 countries including U.S., Japan, Brazil, Paraguay and EU. The use of Stevia leaf and crude extract are not approved by USFDA. JECFA has approved an ADI value for Steviol Glycosides expressed as 4 mg of steviol equivalents per kg body weight per day. Approximately 12 mg of high purity stevia extracts per kg body weight per day.

**Sugar Alcohols:** They are calorific but do not get completely absorbed. Many of them are less

sweet than sugar and need to be used in larger quantities. Due to inadequate absorption they have a laxative effect. They are naturally present in fruits and vegetables but can be synthesized. More than 50 gm of sorbitol and 20 gm of mannitol per day may cause diarrhea. Erythritol is absorbed fully and excreted. Oral bacteria do not grow on them hence they cannot contribute to caries. Sugar alcohols or polyols include Sorbitol, Mannitol, Xylitol, Isomalt, Lactitol and Maltitol.

**Erythritol:** Erythritol is a unique member of the polyol family. It is a tetra-carbon [1,2,3,4-butanetetrol, molecular weight (MW) 122.12] sugar alcohol (or polyol). Erythritol is a naturally occurring substance and found in a variety of foods such as grapes, pears, melons and mushrooms and in fermented products such as soy sauce, sake and wines. It is 60–70% sweeter than table sugar yet with zero calories (a caloric value of 0.2 kilocalories per gram). It neither affects blood sugar nor causes tooth decay. This sugar alcohol is well absorbed by the digestive system, partially absorbed by the body and excreted in urine and faeces as such. The consumption of erythritol from its natural occurrence in foods is estimated to be 25 mg/person/day in united States and is 106 mg/person/day in Japan.

# Section 5: Myths Relating to Low Calorie / Non Nutritive Sweeteners

The safety of low-calorie sweeteners has been confirmed time and time again by different regulatory agencies and scientists from around the world including Health Canada, the USFDA and the European Food Safety Authority (EFSA). Even the National Cancer Institute, Maryland, USA acknowledges that based on decades of scientific research, low-calorie sweeteners are safe ingredients to be included in diet. "There is no clear evidence that the artificial sweeteners available commercially in the United States are associated with cancer risk in humans." However, still there are certain myths among the populations regarding the safety of these low calories, non-nutritive sweetener.

## Do Low-calorie sweeteners actually cause weight gain?

A number of studies over the years have determined that low-calorie sweeteners do not increase appetite, food intake or weight gain. In fact, the vast majority of scientific literature confirms the safety and benefits of using low-calorie sweeteners and low-calorie products for weight control and weight loss. It is reported that low-calorie sweetener not only helps with weight loss, but also with long-term weight maintenance. In another report published in the American Journal of Clinical Nutrition, concluded that low-calorie sweeteners have the potential to aid in weight management. And according to a recent study published in the International Journal of Obesity, consumption of sugar-free beverages sweetened with low-calorie sweeteners increases dietary restraint, a key aspect of successful weight maintenance. However, it is important to remember that low-calorie sweeteners and the products that contain them are not "magic bullets" for weight loss. Instead, they are tools to be used as part of an overall weight control program, which includes a reduction in calories and an increase in activity.

## Are Low-calorie sweeteners safe for use during pregnancy and lactation?

The use of low-calorie sweeteners in pregnancy has been well studied both in humans and in animals. Before approving the currently available low-calorie sweeteners, the U.S. Food and Drug Administration determined that the low-calorie sweeteners are safe for all populations, including

special groups such as the elderly, children, and pregnant and lactating women. Further, leading health groups such as the American Dietetic Association and American Diabetes Association support the safe use of low-calorie sweeteners during pregnancy. Low-calorie sweeteners can help pregnant women enjoy the taste of sweets without excess calories, leaving room for nutritious foods and beverages without excess weight gain. Excess weight gain during pregnancy has been shown to be harmful to both the mother and developing baby.

## Does low- and no-calorie sweeteners increase appetite?

Low- and no-calorie sweeteners have no effect on appetite, but here's how they can help. Since they make low-calorie foods and beverages tastier, they make it easier to follow a lower-calorie regimen. This is well established among those who strive to eat a balanced diet. The federal government's National Health and Nutrition Examination Survey (NHANES) found that people who eat a balanced diet are also likely to drink low- and no-calorie beverages. University of Nevada Cooperative Extension, USA conducted surveys entitled "Continuing Survey of Food Intakes by Individuals" and the "Diet Health and Knowledge Survey" which revealed that people who consume low-calorie foods and beverages are more aware of what they eat, eat a more balanced diet and consume fewer daily calories.

## Does drinking low- and no-calorie beverages lead to a desire for sweets?

Sugar substitutes do not cause sweet cravings, nor do they cause hunger. In the recent Choose Healthy Options Consciously Everyday (CHOICE) study, researchers compared low- and no-calorie beverages with water and found that neither caused food cravings. In fact, the diet beverage drinkers ate less dessert than those who drank water alone. Meanwhile, a scientific review paper that gathered the findings of multiple studies done with children and teens as participants found no evidence that low- and no-calorie sweeteners prompted snacking or overeating at meals.

## Safety of Aspartame

Aspartame is a commonly used low-calorie sweetener that has been extensively tested and declared safe by governmental and independent organizations all over the world. Both the U.S. Food and Drug Administration (FDA) and the European Food Safety Authority (EFSA) have found it to be safe for use in foods and beverages. In fact, EFSA reaffirmed that aspartame is safe for consumption by the

general population. According to decades of scientific research, aspartame can be an effective tool in both weight loss and weight management. It is also recommended as a sugar substitute by the American Diabetes Association.

People have safely consumed products containing Aspartame for more than thirty years. The U.S. Food and Drug Administration (FDA), the Joint Expert Committee on Food Additives (JECFA) of the World Health Organization (WHO) and regulatory agencies in more than 100 countries have reviewed Aspartame and found it safe for use. The American Medical Association, the Academy of Nutrition and Dietetics (formerly the American Dietetic Association) and the American Diabetes Association also recognize Aspartame as safe.

The sweetener has been tested continuously since its introduction and its safety has been consistently re-affirmed. A study conducted by government researchers at the National Cancer Institute involved over 500,000 people, including those who drank the equivalent of three or more diet soft drinks every day for almost a decade. It found that there was no increased risk of any type of cancer even among those who consumed the most Aspartame. In fact, since aspartame was first introduced, no scientific evidence has been found linking it to any disease in humans.

# Section 6: Consumption Of Low - Calorie Sweeteners

The global low-calorie sweeteners consumption will see significant growth in the next ten years, doubling in its size by 2025. Visiongain estimates that in 2015 the market will be worth $11.4bn. The major drivers of the low-calorie sweeteners include the growing demand for diet food, and increasing levels of obesity, diabetes and other metabolic disorders. Moreover, in a environment where sugar prices are constantly rising, food and beverage manufacturers are forced to look for ingredients that can substitute an expensive product. For this reason, non-caloric sweeteners are seen as sugar alternatives which comply with consumer needs for healthy food.

Natural low-calorie sweeteners are seen as the most promising segment of consumption in the long term. There is an increasing demand for natural ingredients. (Visiongain, 2015).

The emergence of diabetes is turning out to be a major problem globally. India has about 65 million diabetics and 77 million pre-diabetics. This will see the number grow to a whopping 100 million plus, confirmed diabetics by 2030. Even children at age of 13-14 are diabetic due to the change in lifestyles – consumption of junk food, fast food, lack of physical activity and obesity.

The increasing awareness of the link between diet and health, the problem of obesity and consumer concern over sugar levels in the diet are leading towards worldwide trend towards cutting down on sugar. The shift away from sugar is still years away but a trend towards low calorie sweeteners is occurring. The world is turning, towards sugar substitutes and low calorie sweeteners. The market for sugar substitutes is being fuelled globally by new-age safe sweeteners.

The ideal sweetener is as sweet or sweeter than sucrose and has a pleasant taste with no aftertaste. Consumer acceptance of a sweetener is closely linked to how similar its taste is to sugar. The ideal sweetener also is colorless, odorless, readily soluble, stable, functional, economically feasible and does not promote dental cavities. It is nontoxic and is either metabolized normally or excreted from the body unchanged without contributing to any metabolic abnormalities, such

as diabetes. Currently, the availability of a variety of low calorie sweeteners allows the use of sweeteners either alone or in combination to achieve the requirements of the ideal sweetener

New sweeteners continue to be developed. People should be confident about using them as their safety in vigorously tested by national and international bodies before their release in the market.

# CONCLUSION

Artificial sweeteners now have a major role in reducing the burden of non-communicable diseases. They are very extensively studied for their safety and only then approved for long term consumption. Joint Expert Committee on Food Additives (JECFA) approved low-calorie sweeteners can be safely consumed by the general population, including people with diabetes, pregnant women and children. One exception is people who have a rare hereditary condition called phenylketonuria (PKU), which means they cannot metabolize phenylalanine, a component of aspartame. For people with diabetes, low-calorie sweeteners can offer a sweet alternative that does not affect blood glucose levels.

Pregnant or lactating women and children can safely consume foods and beverages sweetened with low-calorie sweeteners. Current low-calorie sweetener consumption in children is well below the Acceptable Daily Intake (ADI) for all approved low-calorie sweeteners. Low-calorie sweeteners are often inaccurately linked to adverse health effects, such as seizures, infertility, stomach ailments, and possible effects on kidney and liver function. However, the existing body of research does not support such effects. Health authorities around the world have verified that low-calorie sweeteners are safe.

Low calorie or non-nutritive sweeteners also may help in weight management, blood sugar control, prevention of dental carries, glycemic control and improved sense of well-being and other conditions, but they are not magic bullets. They should only be used in moderation and with a healthy balanced diet and a regular exercise program. It should be known to the consumer that simply using these sugar substitutes alone without reducing carbohydrate from sugary, starchy foods or fat will probably not help control their blood sugar level or energy intake. To help consumers have access to products with low or no calorie as substitutes, education on understanding food and nutrition labels should be carried out. Such products should also be made available to consumers at affordable prices.

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