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Processed sugar: is a necessary evil

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INTRODUCTION

The word sugar is derived from Sanskrit 'sarkara' which means gravel. It is called as shakkara or cheeni or chini in Hindi. In 327 BC, the use of sugar came into existence as an alternative to bee honey during the reign of Alexander the Great. During the Gupta dynasty in 350 BC, production of crystallised sugar was evolved. It was called as 'reed that gives honey without bees' and one of the 'panch amrit' nectars of life. Sugar from cultivated sugarcane had been deliberated in the *Atharvana veda* of Indian religious text. In the nutritional point of view, sugar gives only empty calories without any minerals such as calcium, magnesium and phosphorous. One gram of sugar gives 4 kcal of energy. Sugar used in the day to day life means the refined white sugar and brown sugar produced by processing of milling cane. The minimally processed unrefined traditional sugars are obtained by boiling clarified sugarcane juice until a solid residue is left after evaporation. They contain sucrose, calcium, potassium, iron, molasses of sugarcane and are called as jaggery or *gur* and *khandasari* in India. Minimally processed or natural sugars are better than the refined sugars. Minimally processed sweeteners, like honey or maple syrup, contain more nutrients than highly processed ones, like refined white sugar.

STATUS OF SUGAR CONSUMPTION IN INDIA

In the global level, the share of sugar production by India is 18.44% in the year 2019-2020, while the share in export is only 4%, which signifies that there is high

utilization and demand in the domestic market. Significantly up to 55% of the annual sugar production is procured by bulk purchasers for confectionaries. Intake of 6-12 teaspoons of sugar every day is recommended by the World Health Organisation (WHO). The per capita consumption of sugar in India is approximately 10 spoons per day. On an average, sugar uptake per year per head is approximately18 kg. In addition to it a considerable amounts of sugar in hidden forms from different processed food items are also consumed. A single serving of sugar sweetened beverage contains up to 40 g (10 teaspoon) of free sugars. As per the World Health Organization, the recommended intake levels of sugar for Indians should be less than 10% of an individual's total calories per day, which includes all forms of added sugars in the form of honey, fruit juices and syrups. Under the sponsorship of International Life Sciences Institute, India, a survey was undertaken by Indian Council of Medical Research (ICMR), National Institute of Nutrition, Hyderabad to collect information on the sugar intake (grams per day) by an individual in various metro cities of India. The mean intake of sugars was found be highest in Mumbai and the least in Hyderabad. The findings of the survey revealed that the average daily intake of sugar in all metro cities was 19.5 gram per day as against the ICMR recommended dose of 30 gram per day. On an average, the daily sugar limit for women is 25-28 gram and for men is 37-40 gram. This equals to 5% of the recommended overall calorie intake of 2000 calories per day. The National Federation of Sugar Factories Ltd (NFSFL), India has seen a drop of at least 2 kg in individual sugar consumption per year. Out of 32 million tonnes of sugars produced, we consumed only about 25 million tonnes.

DIFFERENT TYPES OF SWEETENERS

Natural sweeteners

Natural sugars are commonly obtained from Sugarcane, Sugar beet, Sweet sorghum, Sweet potatoes, Maple tree, Coconut or Palm sap, Agave, Honey, Date palm, Monkfruit or *Luo Han Guo* etc., Processed sugars of natural origin are Cane sugar, Jaggery, Cane crystals, Molasses, Raw sugar, Sucrose, Sugar Syrup, Brown sugar, Turbinado sugar, Muscovado sugar, Demerara sugar, Dextrose, Evaporated cane juice, Agave nectar, Carob sugar, Caramel, Treacle, Corn sweetener, Corn syrup, Crystalline fructose, Fructose, Fruit juice concentrates, Glucose, High-Fructose Corn Syrup (HFCS), Invert sugar, Lactose, Maltose and Malt syrup.


Fig.1. Clarification of cane juice using botanicals –*Abelmoschus ficulneus* in jaggery production from sugarcane variety CoC 13339

SUGARS BEYOND SWEETENING: UNEXPECTED USES OF SUGAR

Sugar is one of life's greatest indulgences. It has been consumed throughout the centuries in various forms such as fruits and honey. But in the modern age, sugar is readily available and widely consumed. However, we restrict it in a few applications like sweetening coffee, adding some sweetness to the delicious dishes. Sugar has multifarious uses beyond our expectations. There are many applications of sugar that go beyond sweetness and beyond food.

Sugar is a natural ingredient that has been part of our diet; due to the multiple functions, it is ideal for all kinds of food preparation. Sugar in foods behaves as a sweetener, preservative, substrate for fermentation, texture modifier, bulking agent, flavouring and colouring agent. Sugar has several functional properties in food and so far, no other sweetener has been found or developed to duplicate all or even many of them. These functional properties are derived from the sensory and physical properties of sugar and its multiple reaction and interactions with the other food ingredients.

Novel sweeteners

Sweet from whole leaf extracts of *Stevia rebaudiana*, a South American plant. Highly refined Stevia preparations have been approved as novel sweeteners by the FDA. However, the whole-leaf or crude Stevia extracts is not accepted.

Tagatose is similar to fructose and a low-carbohydrate sweetener that occurs naturally in the lactose of dairy products. The FDA categorizes tagatose as a GRAS substance. The two newly emerging sweeteners are Thaumatin and D-psicose or allulose. Thaumatin is a group basic proteins that are intensely sweet and isolated from the fruit of *Thaumatococcus danielli* (West African Katemfe fruit). Thaumatin is a taste-modifying protein that functions as natural sweetener or flavour enhancer. Allulose is a low-calorie granulated sugar and was first discovered in wheat and certain fruits such as jack fruit, figs and raisins. The most commercially available allulose is produced from corn and sugar beet.

Sugar alcohols as sweeteners

Sugar alcohols (polyols) are carbohydrates that occur naturally in certain fruits, vegetables and microorganisms. They are lower in calories than sugar, less intense sweetener than sugar making them more attractive sugar alternative for diabetes patients. Ethanol is not present in sugar alcohols as in alcoholic beverages. FDA had regulated the use of sugar alcohols in sweet foods. Sugar alcohols contain calories. e.g. sorbitol, xylitol, mannitol *etc*.

Artificial sweeteners

Artificial sweeteners are synthetic sugar substitutes. But they are derived naturally from herbs or from sugar itself. Artificial sweeteners are intense sweeteners and many times sweeter than sugar. Artificial sugars include saccharin, aspartame, acesulfame potassium or ace-K, sucralose (Splenda), advantame, neotame (Newtame) *etc*.

FUNCTIONS OF SUGAR IN FOODS

I. Sugars in food preservation

Sugars are used for the preservation of storage products like jelly, jams, squashes and marmalades so as to protect it from the spoilage of microorganisms. To extend the shelf life of cheeses from turning fuzzy, a cube of sugar placed along with cheese stored contained will absorb the moisten and prevents from molding.

Sweetening of food: The most notable function of sugar in food is its sweet taste. Sweet taste is highly accepted sensorial criteria which gives energy as well as a source of pleasure. Sweetness is one of a few tastes which are experienced from innate.

Preservation of jam and jelly: Sugar is commonly used as preservative in jams and jellies and it also enhances the colour and flavour of various fruits. The hygroscopic nature of sugar plays a crucial role in reducing water activity in foods which helps in preserving and extending the shelf life of jam and jellies. In addition it is also essential to obtain the desired consistency and firmness.

Extend shelf life of baked food: Sugar also acts as humectants in baked foods, which prevents drying out and staleness, thus extending the shelf life of these products. Sugar provides a source of nourishment for the growth of yeast. The browning reaction that sugar undergoes when exposed to heat adds flavour and contributes to the appearance of colour that can be seen on baked foods. Sugar also plays an important role in the texture of bakery products. It tenderizes bakery products by competing with starch molecules and proteins for liquid components in the dough, which prevents over development of gluten and slows down gelanization. During the mixing of dough, sugar promotes lightness by incorporating air in the form of small air cells into the shortening and these air cells will extend due to the gases generated by leavening agents. During cookies preparation, sugar influences the spread of dough and surface cracking. In foam type cakes, sugar interacts with egg proteins to stabilize the whipped foam structure and make it more elastic, so that the air cells can expand.

Determine the texture of candy: Sugar crystallization is a major determinant of the texture for candies. It is minimized to create the soft texture of taffy candies, on contrary, it is maximised to create the desirable grainy texture of hand candies. Higher

concentration of sugar increase the boiling point of solutions used to make candies. The final consistency of the candy is decided by the addition of sugar.

Canning and freezing: Sugar is added to canned fruits and vegetables to improve flavour, enhance texture and preserve natural colours. Sugar is also used to slow the freezing process and prevent large crystal from forming in frozen sweet mixtures such as ice cream.

Keep biscuits and cake fresh: Keep a few sugar lumps in the bottom of the biscuit tin that will absorbs the moisture and keep the biscuits fresh. Sprinkle some sugar on the home made cakes when they are hot and this will keep them longer.

Prevent cheese from molding: Storing cheese with sugar cubes will prevent cheese from molding.

Preserves colour of frozen fruits: Sugar prevents enzymatic browning discolouration of the fruit by protecting the surface of the fruit from contact with air. So, the colour of the fruit will not fade.

Enhance natural flavour of food: In food products, sugar plays a unique role in contributing to the flavour profile by interacting with each other ingredients to enhance certain flavour. Flavour aroma possesses no taste properties, but once combined with sugar, the sweetness of sugar and the flavour aroma work synergistically. Small amount of sugar can be added to cooked vegetables and meat to enhances the food's natural flavour without making them taste sweet. In non sweet foods such as salad dressing, condiments and sauces, sugars enhances flavour and balance the natural acidity of tomato and vinegar based products. This is because sugar is easily broken by weak acids.

Crystallization of ice cream: The level of sugar can affect the ice and crystal crystallization size in the manufacturing of ice cream and other frozen desserts. The sugar's ability to attract and hold water diminishes the water available for crystallization during freezing and as a result, the freezing point for these frozen desserts drops, thus allowing colder temperature to be used during processing. This combination of lower freezing point and colder temperature during processing produces frozen products with extremely small ice crystals and these tiny ice crystals give frozen desserts their desirable smooth and creamy texture.

II. Therapeutic uses of Sugar:

Sugar as additives in medicines: Sugar is used for coating, adding volume or texture and flavouring medicine. It is used as coating agent, texture and flavour enhancers in medicines such as cough syrups. The sweetness of sugar increases the palatability of medicine. It can also be act as a preservative and antioxidant. It also provides other desirable functional properties in pharmaceuticals due to its low toxicity, high purity and diverse physicochemical properties. It can act as an incipient by which the active ingredient of medication is introduced to the body.

Soothe a burned tongue: If the tongue is burnt due to sipping of hot coffee/ tea/ soup, sprinkling few granules of sugar on the tongue will dissipate the pain.

Healing wounds: It acts as a wound healer by absorbing excess moisture of wounds. Sugar has an excellent preservation property that heals the wound effectively. The

moisture of the wound is absorbed by the sugar which prevents the growth of microorganisms.

Immunization shots: When babies are given with sugar water solution orally, before immunization, the pain of the shots is reduced. Intake of sugar water solution before immunization soothes the pain of injecting vaccines into babies.

Bee stings and bug bites: It relieves pain of bee stings and bug bites when applied as a paste along with water. Equal parts of sugar and water are mixed, applied to the affected area and left for about 20 minutes to soothe pain full stings and bites.

III. House hold uses of sugar:

Keep cut flowers fresh for longer: A table spoon of sugar and vinegar to a litre of water in the flower vase, nourishes the stem as the vinegar restrict the growth of bacteria.

Battle garden pest: Hand full of sugar mixed with soil and sprinkled around the plant helps to control nematode. It will encourage the activities of beneficial microorganism. This may create a hostile environment for nematodes.

Trap wasp: Make simple syrup by mixing two parts of sugar with one part of water bringing it to a boil. Once it cools, pour the syrup into a jar and set it out side. The sticky mixture will attract the wasp and trap them.

Banish bugs and cockroaches: Mix equal parts of sugar and baking powder and sprinkle it in an area where you suspect bugs are handing out. Sugar attracts the bugs, baking powder exterminates them. Reapply as needed.

Fight grass stains in cloth: Combine sugar and warm water to create a thick paste, apply directly on the grass stain. When this mixture is allowed for about an hour or two on the stain and washed, the garment becomes stainless.

Clean cruddy hands: Sugar is an abrasive if you have dirty due to oil, grease or paint on hands, rubbing them with sugar to clean them. After cleaning your hands will look and feel clean, soft and moisturized.

Clean the coffee grinder: Coffee grinder can collect oils that are strong in flavour but sugar can clean them by absorbing the elements. Pour ¼ cup of sugar into the grinder and run it for 2 - 3 minutes. Dump out and wipe well.

Sugars in cut flowers preservation: Vinegar blended with sugar is used for preserving cut flowers to keep them fresher for longer duration.

Sugars as insect repellents: It acts as nematode and insect repellent in home gardens. When mixed with baking soda it controls the entry of bugs and cockroaches. Two parts of boiled sugar syrup acts as a lure for beetles and wasps. Non-toxic fly trap can be prepared using sugar. Fruit flies and house flies can cause a lot of problem in the home and garden. If you are batting with them, try this sugar fly trap. To make this, ¼ cup sugar is boiled with ¼ cup of honey and 2 table spoon of water, until sugar is dissolved. Dip pieces of craft or brown packaging paper in the mixture then hang them over night to dry. Make a small hole in the paper and hang with a tread when needed.

Start a fire: If we have a trouble getting a wood or coal to burn during campfire or other time, put a hand full of sugar on to it. This will help to ignite the fire.

Sugars as de-stainers: Sugar acts as stain remover and is used in removing excess oil coats deposited in machines like mixer grinder. It is blended with vinegar and applied over stained clothes before washing.

IV. Uses of sugar in cosmetics:

Moisturizer, pedicure and lipstick extender: It acts as a moisturiser. It acts as lipstick extender. When sugars are applied over the lips coated with lipsticks, the colour extension of the lipsticks can be enhanced. They can be used as cleansers and body scrubs when applied along with oils. In Pedicure, it is used to remove the hard skin on the heels. Pinch of sugar added to any gel soap and using a pumice stone will peel off hard skin.

Remove unwanted hairs: They are used in cosmetics as an exfoliant to remove the dead cells of skin. It acts as body exfoliate. Newer skins are revealed by the application of the coarse sugar which will tend to exfoliate dead skin. People are becoming interested in beauty treatment for removal of unwanted hairs. For this, 2 cups of sugar is mixed with ¼ cup of lemon and ¼ cup of water and then cooked until it becomes dark in colour. This substance can be used with waxing strips to remove unwanted hair naturally.

V. Sugars in industries

Sugar is used in tanning of leather and for sizing and finishing of fabrics. It is used in biofuel production especially ethyl alcohol. Distilled spirits, beer and wine fermentation involve the use of sugar. It acts as an igniting material over stubborn charcoal. When sugar is applied over flame, ignition becomes faster and decomposes rapidly.

PROCESSED WHITE SUGAR FROM CANE JUICE: ARE THEY EVIL?

Human body does not require sugar and has the capability of processing glucose from sugar. But the same glucose can be extracted from starch, protein and fat containing foods consumed by us. Sugar is absolutely not dangerous or evil as such. But the way and the quantity it is consumed causes evil and deleterious effects. In the fast food world, consumption of sugar is not the issue, but rather the quantity in which it is consumed creates a debate.

In India, double sulphitation process is followed for the refining of white plantation sugar as double carbonation process has since been dispensed with. In this process, continuous liming and sulphitation is done in a reaction tank for which continuous supply of sulphur dioxide is obtained from a continuous sulphur burner by burning sulphur in presence of dry air. The chemical reaction takes place as sulphur dioxide + oxygen producing sulphur dioxide.

Clarification of cane juice by double sulphitation process is carried out with lime and sulphur dioxide as agents. This process generally used for clarification of sugar cane juice in white sugar plantation/ manufacturing industry. In this process, excess quantity of lime is added to the cane juice and then it is neutralized by sulphur dioxide. After the addition of lime and SO_2 gas, the sulphited juice heated slightly above the boiling point *i.e.* 102°C to 103°C and it is passed to juice clarifier through the flash tank for setting the

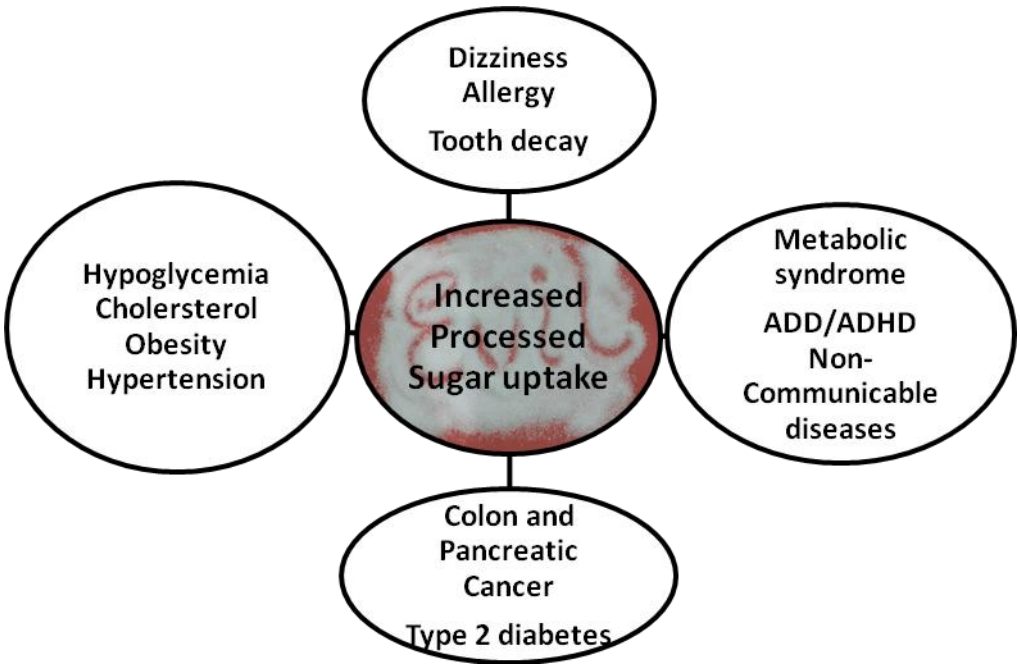
mud. This process is used to control the pH, as a biocide and for preventing Maillard reaction.

At this point besides sulphur dioxide small quantity of sulphur trioxide is also produced. In the continuous reaction tank, at the liquid phase small amount of soluble sulphate is also produced besides the formation of insoluble calcium sulphite. This calcium sulphite in later stage helps in removing various impurities including colloidal matters. Un-sulphured syrup obtained from evaporator is again sulphited in a syrup sulphiter after clarification of cane juice. Here, the excess sulphur dioxide reacts with water forming sulphurous acid. Sulphur dioxide is commonly known as sulphurous acid *i.e*. the anhydride of the sulphurous acid. The presence of this sulphurous acid in sugar increases the sulphur dioxide content of sugar as it is present in sugar as anhydride of sulphurous acid. Because of this, Bureau of Indian Standard: 5982-1970 has stipulated the sulphur dioxide content limit as 70 ppm as the safe tolerance limit. For plantation white sugar limit has been fixed for 70 ppm and for refined sugar it has been fixed as 20 ppm whereas International Standard has been fixed at 10 ppm for refined sugar.

Normally phosphates, silica and magnesium are partially removed by clarification. During refining or sulphitation process, sulphur enters sugar and this remains as a major drawback. Sulphate (SO_3) content in sugarcane juice varies from 0.11% to 0.52%. However, minerals such as potassium, sodium, chloride and low concentration of sulphate are not removed and these constituents tend to get concentrated with onward processing and even pass to the bagging stage. The final processed sugar contains sulphur dioxide approximately to the extent 20 to 70 ppm depending on the process applied and also the condition of the plant and the techniques applied in the manufacture of refined sugar. As per ISI grade of white refined sugar, the maximum permissible limit is 70 ppm. The International standard limit is however 10 ppm only. Therefore the consumers of processed sugar are advised to take sulphur free sugar as prevention is better than cure.

Health hazards of Intake of sulphur dioxide containing sugars

- Intake of sulphur dioxide beyond prescribed limit causes irritation of respiratory tissues; respiratory diseases like bronchitis and asthma and causes breathing difficulty.
- Severe airway obstruction and causes irritation of the upper respiratory tract which sometimes may cause pneumonia.
- Asthmatic patients are more susceptible and cause allergic reaction to sulphur dioxide consumption; Sulphur dioxide on coming in contact with water forms sulphurous acid which inhibits mucociliary transport.
- When sulphur dioxide reacts with water, Bisulphite ions are produced and this induces broncho-constriction.
- Excess intake of sulphur dioxide may cause sneezing, sore throat, wheezing, shortness of breath, chest tightness and suffocation.



Evil effects of processed sugar consumption

- Consumption of too much processed food, especially processed sugar causes type 2 diabetes, a serious and lifelong condition characterized by high blood sugar levels. High levels of sugar intake acts as 'new cholesterol' that lead to accumulation of stored body fat, which can contribute to insulin resistance, and eventually type 2 diabetes. Intake of excess sugar can even affect insulin and leptin resistance of the human body. This also paves the way for certain non-communicable diseases.
- Excess consumption of sugar, contribute to weight gain, which could lead to obesity and the possibility of the onset of chronic disease. Some common health problems caused by sugar are obesity, dysfunctional metabolism and liver damage. Sugar acts like a new tobacco and a narcotic drug which causes addiction. Consumption of sweeteners like aspartame, saccharin, and sucralose are linked to weight gain, not weight loss, to a higher risk for high blood pressure, type 2 diabetes, metabolic syndrome, heart attacks, and stroke.
- There is an increased link between higher sugar consumption and infertility. A poor quality diet of the female, including the increased consumption of added sugar and sugary drinks, has been linked with poorer egg quality and pregnancy outcomes. Lower sperm motility often occurs due to the consumption of sugar-sweetened beverage even in healthy young men. Caffeinated energy and soft drinks results in reduced fertility.
- Sugary drinks and artificially sweetened beverages are associated with a higher risk of cardiovascular disease.
- Attention Deficit Hyperactivity syndrome (ADHD), bipolar disorder, and even aggressive behaviours may be linked with high sugar intake.
- Sugar-rich diet can damage gut mucosa and worsen risk of developing colitis, a chronic digestive disease. It was seen that there was an increase in the number

of *Akkermansia muciniphila* and *Bacteroides fragilis*, which are considered to be mucus-degrading bacteria.

CONCLUSION

Innovation is the key for nudging the sugar industry to undertake initiatives to popularise various traditional sugar products and fresh juice. There is a lot of misconception about Indian sugar abroad and it is not considered to be at par with Brazilian or Thai sugar. We need to counter that narrative and should be aggressive in marketing ISMA will be holding workshops and webinars, where nutritionists, dieticians, endocrinologists, public health specialists, medical practitioners, sugar producers and consumers would share their expertise, ideas and knowledge on the subject. The portal would also share information about the consumption, utilization and the value of natural sugar and traditional sugar products. Furthermore, it is more convincing to take less processed sugars such as palm sugar, country or brown sugar from cane juice, maple syrup, honey, agave nectar. Processed sugar is not an evil or devil unless the dose of consumption or per day intake is optimal.

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