

Sugar: A Therapeutic Dichotomy—Integrating Contemporary Evidence on Metabolic Risks with Ayurvedic Pharmacotherapeutic Applications

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Abstract

Sugar plays a significant role in human nutrition and culinary traditions, particularly in India, where it is deeply ingrained in daily life and rituals. While sugar is an essential source of carbohydrates and energy, its overconsumption is linked to numerous health concerns, including obesity, type 2 diabetes, cardiovascular disease, dental decay, fatty liver, and gastrointestinal disturbances. Ayurveda classifies sugar and sweet substances not only by their origin but also by their therapeutic properties. Substances such as jaggery, *khandasharkara*, honey, and coconut sugar are highlighted for their medicinal value and nutrient content. Classical Ayurvedic texts describe different types of sugar derived from sugarcane and honey, elaborating on their dosha-balancing properties and uses in various formulations. This review will guide a shift towards mindful eating practices by introducing Ayurvedic sweeteners into the daily diet that align with individual constitutions and health needs. By understanding the role of sugar in both modern nutrition and traditional medicine, readers are empowered to make informed dietary choices that support overall well-being.

Key words– Sugar, health, Food, Sweetness, diabetes.

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INTRODUCTION

Sugar is one of the primary sources of carbohydrates. In India, sugar is not just a food ingredient, but it is a part of daily life, traditions, and celebrations. The major sources of sugar include beet or cane sugar, as well as several other sources, such as honey, corn syrup, fruits, and vegetables. The primary function of sugar in food products is to provide sweetness and energy. In addition, sugar plays an important role in preservation, fermentation, colour, and texture.¹ They are a source of calories and, in addition to sweetening, perform many essential technical functions in both processed foods and home-prepared foods. Although recent research has focused on the relationship between added sugars and health, such as the possibility that excessive intake of sugars contributes to obesity and nutritionally inadequate diets, these concerns are primarily about overconsumption of sugars.² Sugar provides the body with instant energy, but too much sugar is unhealthy. The body uses all sugars the same way; it changes them to glucose, which is what our body uses for energy.

Ayurveda, the ancient science of life, regards food as a tool for maintaining health and preventing

disease. Among the six fundamental *Rasa* (tastes), *Madhura* rasa (sweet taste) is associated with nourishment, strength, and satisfaction. The sweet taste is said to balance *Vata* and *Pitta* doshas while promoting stability in the body and mind. While Ayurveda acknowledges the therapeutic value of naturally sweet substances like honey, jaggery, and certain fruits, it also warns against the overuse of refined sugars, which can lead to imbalance, toxin accumulation, and chronic health issues. In Ayurveda, sugar is described as an ingredient in numerous formulations, such as *Prakshepaka Dravya* (ingredients) and *Anupana* (adjuvant). According to Ayurveda treatises, sugar is a form mainly derived from juice extracted from the sugarcane plant³.

MATERIALS AND METHODS

A comprehensive review of the major Ayurvedic classics, including the Charaka Samhita, Ashtanga Hrudaya, and Sushruta Samhita, was conducted to gather data on sugar, sugarcane preparations, and their various qualities. Several sites, including Google Scholar, PubMed, ResearchGate, and Ayush Research Portal, were also thoroughly searched.

OBSERVATION AND RESULTS

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Definitions of sugars⁴

Total sugars: Total sugars comprise all added sugars in foods and drinks as well as naturally occurring sugars like lactose, which is found in milk, and sugars found in the structure of whole fruits and vegetables.

Free sugars: Free sugars include the natural sugars found in honey, syrups, fruit juices, and fruit juice concentrate, as well as the monosaccharides and disaccharides that are added to food and drink by the manufacturer, culinary professional, or consumer.

Added sugars: Added sugars include those found in honey and concentrated fruit or vegetable juices, as well as sugars added to food during food processing and as sweeteners. Natural sugars, such as those found in pure fruit and vegetable cell walls or milk, are not considered added sugars.

SOURCES OF SUGAR:

Sugars are the monosaccharides and disaccharides, which are crystalline, water-soluble, and sweet compounds.

Monosaccharides- Fructose, Glucose, Galactose. These do not occur in free form in nature. Disaccharides- Sucrose, Lactose, Maltose.

Natural Sources of Sugar

Sugar	Description	Sources
Glucose or Dextrose	Glucose is made from corn starch by hydrolysis. Glucose is formed in sugar syrup if an acid is present.	Honey, fruit, and plant juices are a part of the cane and beet
Fructose	It is the most soluble of all sugars and is also the sweetest of all natural sugars.	Honey, fruit juices, are a part of cane and beet sugar
Maltose	When starch is hydrolysed with an acid, maltose is formed as an intermediate product.	It is present in germinating cereals and malted products.
Lactose or Milk Sugar	The sugar present in cow's and buffalo's milk contains, on average, 5% lactose while human milk contains about 7%.	The milk secreted by females of mammals.
Sucrose	It is a common sugar available in the market. In India, it is made from sugarcane and is 99.9% pure sucrose.	Sugar beet, Sugar cane, Sugar palm, Sugar maple, Fruit, and plant juices.

Common Sources of Added Sugar⁵

- Sugary drinks: sodas, sweetened teas, energy drinks, sports drinks

- Baked goods: cookies, cakes, pastries, muffins
- Breakfast cereals: Many contain high levels of added sugar
- Candy and chocolates
- Ice cream and other desserts
- Flavoured yogurt
- Sauces and condiments: ketchup, BBQ sauce, sweet chili sauce
- Processed and packaged foods: granola bars, protein bars, frozen meals

TYPES OF SUGAR

Many authors have discussed the many types of sugar, their characteristics, and their therapeutic use in Ayurveda.

According to Acharya Charaka, varieties of sweets derived from sugarcane juice have been mentioned.⁶

Kshudraguda-This *guda* is prepared by boiling sugarcane juice and reducing it to one-fourth, one-third, or one-half. It has more impurities.

Dhautaguda- It has very low impurities.

Matsyandika: Further purification of *Dhauta Guda* turns it into *Matsyandika*.

Khanda Sharkara: It is considered extremely pure. Acharya Charaka has also mentioned the type of *Sharkara* (sugar) based on origin, along with their properties.⁷

Guda sharkara- *Sharkara* prepared from sugarcane juice. It is *vrushya* (aphrodisiac), *snigdha* (unctuous), and it is good for those who are weak.

Yavasa Sharkara: *Sharkara* is prepared from the *Yavasa* plant. It is *Kashaya* (astringent), *Madhura* (sweet), *Satikta* (slightly bitter) in taste, and *Sheeta* (cold in potency).

Madhu Sharkara: This *sharkara* is prepared from *Madhu* (honey). It is *Ruksha* (dry) and is used in the treatment of vomiting and diarrhoea.

According to Acharya Sushruta, he has explained different preparations of *Guda* and their properties.⁸

Phanita-It is heavy for digestion, sweet, nourishes the body, non-aphrodisiac, and aggravates all three doshas.

Guda- It is sweet and slightly alkaline, cold, unctuous, purifies urine and blood,

Shuddha guda- alleviates *pitta* and *vata*, is sweet, and purifies the blood.

Purana guda- it is considered superior with high quality and is beneficial for health.

Matsyandika, Khanda, and Sharkara-These are prepared from purified cane sugar. They are *Sheeta* (cold in potency), *Snigdha* (unctuous), *Madhutara* (sweeter), and *Gurutara* (heavier) in successive order, respectively. They are *Vrushya* (aphrodisiac) and alleviate bleeding disorders and thirst.

Madhu sharkara-helps in the treatment of vomiting and diarrhea. It is *ruksha* (dry), cleanses the tissues, *Kashaya-madhura* (astringent-sweet in taste), and sweet after digestion.

Yavasasharkara—It is sweet-astringent in primary taste, bitter in secondary taste, alleviates *kapha*, and is laxative. Dalhanam mentioned that *Yavasasharkara* is prepared by boiling the decoction of the *yavasa* plant till it becomes solid.

Madhuka-pushpaPhanita—Phanita prepared from flowers of the *Madhuka* tree is dry, increases *vāta* and *pitta*, mitigates *kapha*, sweet in taste and astringent after digestion, and vitiates the urinary bladder (causes aggravation of dosas there).

Acharya Vagbhata has mentioned four types of *guda* with their properties.⁹

1. **DhautaGuda**—it is *isnaati-shleshma-kara* (does not cause an increase of *kapha*) and it helps in easy evacuation of *mutra* (urine) and *shakrut* (faeces).

1. **AdhautaGuda**—Causes *prabhutakrmi* (extensive worm infestation) and vitiates *majja* (marrow), *asrka* (blood), *meda* (adipose tissues), *mamsa* (muscles), and *kapha dosha*.

3. **Puranaguda**—It is *hrdya* (cardiac tonic) and *pathya* (wholesome).

4. **Navaguda**—Vitiates *shleshma* and causes *agnisada* (weakened digestive strength).

Acharya Vagbhata has also mentioned other preparations of sugarcane, including *Matsyandika*, *Khanda*, and *Sita*. These preparations are used in the treatment of *Raktapitta* (bleeding disorders) and *aggravatevata*. He also mentioned *Yavasasharkara*, which has similar properties to *Sharkara*. It is *Tikta* (bitter), *Madhura* (sweet), and *Kashaya* (astringent). Among all the preparations of sugarcane, *Sharkara* is *vara* (best) and *Phanita* is *avara* (worst) in terms of qualities⁹

Various sugars used in the Indian community:

1. **Khandsari sugar**¹⁰—This product is made from sugarcane juice that was obtained using the open pan method. In Ayurveda, it is considered sweet, enhances taste, helps in bleeding disorders, and relieves burning sensations.

2. **Jaggery**¹⁰—According to FSSAI (2018), “Gur or jaggery is the product made by boiling or processing juice that is extracted from palmyra, date, or coconut palms, or pressed out of sugarcane”.

3. **Cane Jaggery**¹⁰—Cane Jaggery or Cane Gur refers to the product derived by boiling or processing the juice extracted from sugarcane (*Saccharum officinarum*). It must be free from any substances that are hazardous to health.

4. **Liquid Jaggery**¹¹—The intermediate product, which resembles semi-liquid syrup, is obtained after the concentration of pure sugarcane juice during the jaggery-making process. In most parts of West Bengal and Maharashtra, liquid jaggery is a staple food that is commercially valuable.

5. **Honey**¹²—A natural sweetener produced by bees, honey is rich in amino acids, antioxidants, enzymes, vitamins, and minerals. It is known for its

antimicrobial properties, wound-healing benefits, and ability to soothe nighttime coughs.

6. **Brown Sugar**¹³—There are two varieties of these sugars: light brown sugar and dark brown sugar. The brown sugar is covered in molasses syrup, which gives it its unique flavor and color.

7. **Coconut Sugar**¹⁴—Extracted from the sap of coconut palm flower buds, coconut sugar retains several nutrients from the coconut palm.

8. **Granulated Sugar**¹³—Also known as table sugar, this is the most common type, characterized by fine crystals. It can be produced from either sugarcane or sugar beets.

9. **Powdered Sugar**¹³—Also known as icing sugar or sucre glace, this finely ground sugar dissolves quickly and delivers a rapid energy boost due to its high glucose content.

10. **Sanding Sugar**¹⁵—A coarse, shiny sugar with large crystals, often used for decorative purposes. It is essentially refined sugar with no nutritional value, offering only empty calories.

Effects of Excess Sugar

Weight Gain and Obesity: The extra calories from sugary foods can lead to fat accumulation. According to a study conducted as part of the Hellenic National Nutritional Health Survey, children and adolescents who consumed 10% or more of their energy intake from added sugars were more likely to be obese than those who consumed less¹⁶.

Type 2 Diabetes: Over time, high sugar intake may lead to insulin resistance. Sugar-sweetened beverages have been linked to elevated fasting glucose and insulin as well as altered insulin signalling in several animal and human studies.¹⁷

Heart Disease: Excessive sugar can raise blood pressure and increase triglyceride levels. A Swedish population study with a mean follow-up of 19.5 years found that added sugar was positively correlated with stroke and coronary events.¹⁸

Dental Problems: Sugar feeds bacteria in the mouth, contributing to tooth decay. A recently conducted longitudinal study reported a linear dose-response relationship between the intake of sugars and caries development¹⁹

Liver Fat: Fructose is metabolized in the liver and can contribute to fatty liver disease when consumed in excess. A systematic review and meta-analysis show that higher consumption of sugar-sweetened beverages was positively associated with a 40% increased odds of Non-alcoholic fatty liver disease.²⁰

Gastrointestinal- The accumulation of sugar in the colon increases the osmotic load, as well as the fermentation rate by the colonic microbiota, and promotes abdominal pain and intestinal dysfunctions²¹

Mood Swings: Rapid changes in blood sugar impact mood stability and energy levels.

Studies indicate a role for high-sugar diets in anxiety, stress, hyperactivity, and conduct issues.²²

How sugar affects organs in the body²³

Brain: The brain's functional connectivity, which is linked to its functional qualities and brain matter, gets disoriented when glucose levels rise too high. This problem can cause the brain to shrink or can even lead to brain atrophy.

Eyes: A high blood sugar level may cause the lens of the eye to expand, leading to blurred vision.

Teeth: Consuming sugar through the mouth causes it to interact with the oral bacteria already present. When bacteria and plaque consume sugar, they produce acid as a waste product, which gradually erodes the tooth enamel.

Heart: According to a 15-year study, people who consume 17–21% of their calories from added sugars are 38% more likely to die from cardiovascular disease than people who get 8% of their calories from added sugars.

Pancreas: The primary role of glucagon is to increase blood sugar levels, whereas the primary role of insulin is to decrease blood sugar levels. If the pancreas is unable to produce and regulate blood sugar properly, inappropriate blood sugar imbalances can lead to various health issues, like Type 1 and Type 2 diabetes.

Liver: An excessive amount of fructose that cannot be converted to energy in the liver causes liver issues. Because the excess sugar cannot be utilized for energy, the liver converts it to fat.

Stomach: Artificial sweeteners present in candies and medications, such as sorbitol, mannitol, and xylitol, can contribute to diarrhoea.

Bladder: A combination of bacteria and excess sugar in the body raises acid levels, which leads to a urinary tract infection, or UTI.

Feet: A prolonged period of elevated blood sugar could harm and cause damage to the nerves, leading to diabetic neuropathy.

The therapeutic role of sugar²⁴

Sugar (*Sharkara*) is described in the Ayurvedic Pharmacopoeia of India (API) as a valuable dietary and therapeutic substance with applications in a wide range of disease conditions. Owing to its *Madhura Rasa* (sweet taste), *Sheeta Veerya* (cooling potency), *Brimhana* (nourishing), *Balya* (strength-promoting), and *Rasayana* (rejuvenating) properties, it is traditionally used both as a medicine and as an adjuvant (*Anupana*) to enhance the efficacy and palatability of herbal formulations. According to the API, sugar is indicated in *Arsha* (haemorrhoids), where it helps soothe irritation and burning; *Aruchi* (loss of taste or tastelessness), by improving palatability and stimulating food intake; *Bhrama* (vertigo), by providing quick nourishment and relieving weakness; *Chardi* (emesis), owing to its cooling and soothing effects; *Daha* (burning sensation), by alleviating excessive heat and *Pitta*

aggravation; *Daurbalya* (general weakness), through its energy-restoring and strengthening actions; and *Jvara* (fever), where it supports hydration and replenishes energy lost during illness.

The API further recommends sugar in conditions such as *Krmi* (worm infestation), where it serves as a supportive ingredient in specific formulations; *Kshata* (wounds or tissue injury), due to its nourishing and tissue-repair-promoting properties; *Madatyaya* (alcohol intoxication or alcoholism), to counter dehydration, burning sensation, and fatigue; *Moha* (delusion or altered consciousness) and *Murccha* (syncope), where it provides rapid energy and supports recovery from exhaustion. It is also indicated in *Raktapitta* (bleeding disorders) because of its cooling and haemostatic attributes, *Shrama* (fatigue or lethargy) by restoring vitality, *Trushna* (excessive thirst) through its hydrating and cooling effects, *Vatarakta* (gout) by mitigating aggravated *Vata* and *Pitta* symptoms, and *Vishavikara* (disorders due to poisoning), where it is employed as an adjunctive remedy to reduce burning sensations and support recovery. These classical indications highlight that, in Ayurveda, sugar is regarded not merely as a sweetening agent but as a therapeutic substance with restorative, cooling, and rejuvenating properties when used judiciously and in accordance with individual constitution (*Prakriti*), disease condition, and prescribed dosage²⁵.

Pharmacological activities of sugar²⁶:

1. Anticancer Activity: Sugar moieties in drugs like doxorubicin and bleomycin contribute to selective action against tumor cells.

Antidiabetic Activity: Sugar derivatives such as D-xylose, miglitol, and voglibose help reduce blood glucose and enhance insulin sensitivity.

Analgesic and Anti-inflammatory Activity: Sugars like D-ribose and D-allose reduce inflammation in various models (e.g., kidney and cerebral injury). Synthetic sugar derivatives have shown significant pain-relieving and anti-inflammatory effects comparable to standard drugs.

Antiviral Activity: Sugars form part of antiviral drugs like oseltamivir and zanamivir (influenza). Iminosugars (e.g., 1-deoxynojirimycin, celgosivir) have shown activity against viruses, including dengue and SARS-CoV-2.

Antibacterial and Antifungal Activity: Antibiotics such as aminoglycosides and macrolides depend on sugar components for their efficacy. Sugar esters and modified sugars have been found effective against drug-resistant bacterial and fungal strains.

DISCUSSION

In Ayurveda, the taste is not merely a sensory experience but a fundamental aspect of health and well-being. Among the six recognized tastes, *Madhura rasa* (sweet taste) stands out for its

nourishing qualities, attributed to a combination of the *Prithvi* (earth) and *Jala* (water) *Mahabhuta* (elements). From infancy to old age, the sweet taste plays a crucial role in promoting growth and sustaining bodily functions. While the sweet taste is essential for overall health, Ayurveda emphasizes the importance of moderation. Acharya Charaka has emphasized the health effects of excessive consumption of *Madhura rasa*, which may lead to various health issues, primarily due to its aggravation of *Kaphadosha*. This can manifest as obesity, lethargy, excessive sleep, low digestive power, and even certain diseases like diabetes²⁷. Despite these risks, sweetness remains an integral part of a balanced diet, particularly for children, the elderly, and pregnant women.

WHO recommendations on free sugars²⁸

WHO has issued recommendations to reduce the intake of free sugars throughout the life course. In both adults and children, the WHO recommends reducing the intake of free sugars to less than 10% of total energy intake. Moreover, the World Health Organization recommends that the use of free sugar should not exceed 5% of total energy intake. A conditional recommendation is issued when the evidence around the benefits and risks of an intervention is less certain. Conversations with stakeholders are encouraged before policy-making and implementation to discuss the balance between the benefits and undesired outcomes of further reduction.

The Right Sugar Intake for Every Age

In the initial months of life, carbohydrates supply about 40% of the total energy from breast milk, with lactose serving as the primary source. As the infant grows, this percentage gradually increases throughout the first year, eventually aligning with the carbohydrate intake levels recommended for adults. According to the European Food Safety Authority (EFSA) Committee of Experts, total carbohydrates should contribute between 45% and 60% of overall energy intake, with sugars accounting for less than 10% of total energy intake across all age groups, excluding children under 2 years of age²⁹.

Steps for Reducing Added Sugars in Your Diet

- Use the Nutrition Facts label as a guide to cut back on added sugar intake. The Nutrition Facts label on food and drink packaging indicates the grams (g) of total sugars per serving as well as the grams (g) and percentage of daily value (%DV) of added sugars per serving.
- The Nutrition Facts label for single-ingredient sugar products and containers (such as table sugar, maple syrup, or honey) will show the percentage DV for added sugars, and a footnote may include the gram quantity per serving.
- Added sugars have a daily value of less than 50 grams. This depends on a daily calorie intake of

2,000. Depending on how many calories you need, your daily value could be higher or lower.

- Choose foods that provide less than 100% of the daily recommended intake of added sugars by comparing them. Additionally, keep in mind that:

- i) 5% DV or less of added sugars per serving is regarded as low
- ii) Added sugars of 20% DV or more per serving are regarded as excessive.

- Add fruit to salads and side dishes, and for the snacks and desserts, replace whole fruit (fresh, frozen, dried, and 100% fruit juice).

- Try plain, fat-free, or 1% low-fat yogurt and fruit sauces (like applesauce) without sugar or sweeteners.

- When topping foods like cereal, oats, pancakes, and yogurt, use fruit rather than sugars, syrups, or other sweet toppings.

- Choose drinks like water and fat-free or 1% low-fat milk more frequently.

- Restrict the quantity of sugar you use in baking, cooking, and eating.

- Limit your intake of foods and drinks with added sugars, or eat them less frequently.

- Ask for sugars, syrups, or other sweet toppings to be given "on the side" when dining out, and then use the least of them.

CONCLUSION

Carbohydrates in the form of sugar are a vital nutrient that should be included in the diet across various life stages and physiological conditions, as recommended by health guidelines. The issues linked to sugar may arise from excessive intake rather than their presence in the diet. While polysaccharides should make up the largest portion of carbohydrate consumption, sugars can also be part of a balanced and healthy diet. They are important during life stages that demand higher glucose levels, such as childhood, for supporting attention and learning, and old age, for maintaining appetite and aiding in the absorption of essential nutrients. Additionally, sugar plays a key role in sports nutrition. Even in small quantities, sugar provides significant dietary enjoyment, particularly for certain age groups, making it a valuable component of proper nutrition.

REFERENCES:

- 1 Zaitoun M, Ghanem M, Harphoush S. Sugars: Types and their functional properties in food and human health. *International Journal of Public Health Research*. 2018 Oct;6(4):93-9.
- 2 Bueno MB, Marchioni DM, César CL, Fisberg RM. Added sugars: consumption and associated factors among adults and the elderly. São Paulo, Brazil. *Revista*

- Brasileira de Epidemiologia. 2012;15:256-64.
- 3 Manasa BS, Harshitha M. Ayurvedic and modern review on types of Sugar. *J Ayurveda Integr Med Sci*. 2021;5:252-256.
- 4 Macdonald IA. Free sugars. *Proc Nutr Soc*. 2020 Feb;79(1):56-60. doi: 10.1017/S0029665119001046. Epub 2019 Jul 18. PMID: 31317838.
- 5 O'Connor L, Imamura F, Brage S, Griffin SJ, Wareham NJ, Forouhi NG. Intakes and sources of dietary sugars and their association with metabolic and inflammatory markers. *Clinical Nutrition*. 2017. doi: 10.1016/j.clnu.2017.05.030.
- 6 Sharma RK, Dash B, editors. English Translation of Charaka Samhita of Agnivesha, Sutra Sthana, Vol. I, Ch. 27, Ver. 237-240. Varanasi: Chaukhamba Sanskrit Series Office; Reprint 2017. p.538-539.
- 7 Sharma RK, Dash B, editors. English Translation of Charaka Samhita of Agnivesha, Sutra Sthana, Vol. I, Ch. 27, Ver. 241-242. Varanasi: Chaukhamba Sanskrit Series Office; Reprint 2017. p.539.
- 8 Srikantha Murthy KR, editor. Sushruta Samhita of Sushruta, Sutra Sthana. Ch. 45, Ver. 159-169. Varanasi: Chaukhamba Orientalia; Reprint 2017. p.356-358.
- 9 Yadav Premchand D. Vagbhata's Astanga Hrdaya, Sutra Sthana, Ch. 5, Ver. 47-50. 1st ed. Varanasi: Chaukhamba Surbharati Prakashan; 2014. p.126-128.
- 10 Food Safety and Standards Authority of India. Chapter 2.8: Sweetening agents including honey [Internet]. New Delhi: Food Safety and Standards Authority of India; [cited 2025 Jun 24]. Available from: https://www.fssai.gov.in/upload/uploadfiles/files/9_%20Chapter%202_8%20%28Sweetening%20agents%20including%20Honey%29.
- 11 Hirpara P, Thakare N, Kele VD, Patel D. Jaggery: A natural sweetener. *Journal of Pharmacognosy and Phytochemistry*. 2020 Jan;9(5):3145-8.
- 12 Santos-Buelga C, González-Paramás AM. Chemical Composition of Honey. In: Alvarez-Suarez JM, editor. *Bee Products – Chemical and Biological Properties*. Springer, Cham; 2025. https://doi.org/10.1007/978-3-031-89049-9_3.
- 13 Patil H, Peshave M. Study on the Types of Sugar used in various culinary products. *Soult Sarita An International Bilingual Peer Reviewed Refereed Research Journal*. 2021 Jan;8(29):314-8.
- 14 Trinidad T, Mallillin A, Avena E, Rodriguez R, Borlagdan M, Cid KB, Biona K. Coconut sap sugar and syrup: a promising functional food/ingredient. *Acta Manilana*. 2015;63:25-32.
- 15 The Sugar Association. The science of sugar [Internet]. Washington (DC): The Sugar Association; [cited 2025 Jun 24]. Available from: <https://www.sugar.org/resource/the-science-of-sugar/>.
- 16 Magriplis E, Michas G, Petridi E, Chrousos GP, Roma E, Benetou V, Choleopoulos N, Micha R, Panagiotakos D, Zampelas A. Dietary Sugar Intake and Its Association with Obesity in Children and Adolescents. *Children (Basel)*. 2021 Aug 3;8(8):676.
- 17 Sangüesa G, Cascales M, Griñán C, Sánchez RM, Roglans N, Pallàs M, Laguna JC, Alegret M. Impairment of Novel Object Recognition Memory and Brain Insulin Signaling in Fructose- but Not Glucose-Drinking Female Rats. *Mol Neurobiol*. 2018 Aug;55(8):6984-99.
- 18 Janzi S, Ramne S, González-Padilla E, Johnson L, Sonestedt E. Associations Between Added Sugar Intake and Risk of Four Different Cardiovascular Diseases in a Swedish Population-Based Prospective Cohort Study. *Front Nutr*. 2020 Dec 23;7:603653.
- 19 Bernabe E, Vehkalahti MM, Sheiham A, Lundqvist A, Suominen AL. The Shape of the Dose-Response Relationship between Sugars and Caries in Adults. *J Dent Res*. 2016;95(2):167-72.

- 20 Asgari-Taee F, Zerafati-Shoae N, Dehghani M, Sadeghi M, Baradaran HR, Jazayeri S. Association of sugar-sweetened beverages consumption with non-alcoholic fatty liver disease: a systematic review and meta-analysis. *Eur J Nutr.* 2019 Aug;58(5):1759-1769.
- 21 Omer A, Quigley EMM. Carbohydrate Maldigestion and Malabsorption. *Clin Gastroenterol Hepatol.* 2018;16:1197-1199.
- 22 Beecher K, Alvarez Cooper I, Wang J, Walters SB, Chehrehasa F, Bartlett SE, Belmer A. Long-Term Overconsumption of Sugar Starting at Adolescence Produces Persistent Hyperactivity and Neurocognitive Deficits in Adulthood. *Front Neurosci.* 2021;15:574111.
- 23 Crosier A. How Sugar Affects the Body from Head to Toe. *Integrated Studies.* 2020;254. Available from: <https://digitalcommons.murraystate.edu/bis437/254>.
- 24 Kumar A, Singh S. The benefit of Indian jaggery over sugar on human health. In: *Dietary Sugar, Salt, and Fat in Human Health.* Academic Press; 2020. p.347-359.
- 25 Government of India. *Ayurvedic Pharmacopoeia of India. Part I, Vol. 6.* Delhi: Government of India; p.219.
- 26 Spriha SE, Rahman SA. A review on biological activities of sugars and sugar derivatives. *Dhaka University Journal of Pharmaceutical Sciences.* 2022 Jun 9:381-94.
- 27 Sharma RK, Dash B, editors. *English Translation of Charaka Samhita of Agnivesha, Sutra Sthana, Vol. I, Ch. 26, Ver. 42(1).* Varanasi: Chaukhamba Sanskrit Series Office; Reprint 2017.
- 28 World Health Organization. WHO Calls on Countries to Reduce Sugar Intake among Adults and Children [Internet]. World Health Organization; 2015. Available from: <https://www.who.int/news/item/04-03-2015-who-calls-on-countries-to-reduce-sugars-intake-among-adults-and-children>.
- 29 Partearroyo T, Campayo ES, Moreiras GV. Sugar at different stages in life, from childhood to old age. *Nutr Hosp.* 2013;28(Suppl 4):S40-7.