

A review on natural sweeteners and flavors

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ABSTRACT

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Natural Sweeteners are chemical substances that are present in nature. They can be synthesized chemically. They have a sweet taste. So, they can be used as a Sweetening and Flavoring agent. Sweeteners and Flavors are not just used to give taste but it also has effect on health of consumers. Thus, Sweeteners and Flavors found naturally or added artificially to food, are very essential ingredients of human diet. In this article we discussed different natural ingredients used as food and can be use for imparting sweetness and flavors like honey, molasses, maple syrup, coconut sugar, agave nectar, date sugar, xylitol and stevia and some risk factors associated with too much consumption of natural sweeteners and flavors. By consuming these foods in excess amount people develops obesity which in turn lead to chronic diseases like CAD, hemorrhage, diabetes and compromising immunity due to conversion of beneficial intestinal microbiota into pathogenous one.

It has been concluded that these chronic diseases can be prevented by doing life style changes, restricting high calorie diet and by avoiding artificial sweeteners and flavors. Natural sweeteners and flavors are generally harmless but NNS (National Nutrition Survey) suggested that both natural and artificial flavors can be hazardous to health. So, both can be taken in low amount.

Keywords: Natural sweeteners , xylitol, stevia, GUT microbiota Coronaviruses,

INTRODUCTION

Natural Sweeteners are chemical substances that are present in nature. They can be synthesized chemically. They have a sweet taste. So, they can be used as a Sweetening and Flavoring agent. From 1000's of year diet of humans consist of sugars derived from honey, fruits and berries. Moreover, in

the starting of twentieth century Sucrose was considered as an important Sweetener and was used by food industries and consumers. Sweeteners and Flavors are not just used to give taste but it also has effect on health of consumers. Thus, Sweeteners and Flavors found naturally or added artificially to food, are very essential ingredients of diet of humans. The most required flavor from all

flavors is a Sweet flavor. It has impact on our all sensations and even it helps to accept or reject the food item. Most of the people consider sweetness as Energizing, safe and have strength. Sweeteners are classified because of its origin (Natural & Synthetic ingredients) Technical functions (Fillers and Sweeteners) Their texture (Syrups & Powders) Nutritional Importance (Non-Caloric & Caloric). Human beings are facing challenges due to alteration in patterns of diet. Currently, billions of people are suffering from insufficient diet which consists of Added sugars, processed and fats rich food. By consuming these foods people develop Obesity. Their consumption also leads to severe diseases like CAD (Coronary artery disease and diabetes).

Prevalence of diabetes and obesity is due to change in lifestyle of people. It also increases awareness of people to the food they eat. So, people are searching alternatives of sugar which are healthy for them. Beside them Natural sweeteners are normally considered as harmless. But there is concern about increasing their intake because they can be dangerous to health in high amount. Not only sweetening they can also use to give Flavor, Preservation, Texture and Color [1]. As per definition, Flavor is complicated senses resulting from food characteristics which are put in mouth and is considered via the sensation of taste and smell. Natural flavors are found in natural products which are produced in them via Voluntary enzymatic reactions in the duration of storage and Processing [2].

TYPES OF NATURAL SWEETENERS AND FLAVORS

There are many types of natural sweeteners and flavors but some of them are following.

- Honey
- Molasses
- Maple syrup
- Coconut sugar
- Agave nectar
- Date sugar
- Xylitol
- Stevia

Honey

Honey is naturally occurring sweet and viscous syrup. It is collected from flower's nectar via honey bees. It has a nice and amusing taste and aroma. According to the geographical conditions and seasonal variations its color is ranging from pale yellowish to darker amber color. It is known as a sweetener in various parts of the world. Historically, honey also has a religious importance. It has a greatest nutritional importance due to lipids, Minerals, Vitamins and Amino acids. Honey has an important Antimicrobial and medicinal value. It is used in the preparation of food. For good qualities of product, appropriate processing of the honey is necessary. Honey can be adulterated. Before its use, its adulteration can be verified. It can be used in food, Bakery items, Snacks, confectionary, Beverages and in Vegetable and food items as a flavoring agent. There is various on-going researches on honey. Honey which is a both sweetener and flavor is a safe, extremely nutritious and rich in antioxidant. In fruit beverages it is a substitute of Sugar (Table sugar). Lemonade (Lemon juice) which provides a richest source of Minerals, Carotene, Vitamin C. it is flavored with honey to make lemon beverages. Honey is tested for

physical and chemical properties in both forms (Processed and Raw form) [3].

Molasses

From the 19th century, Molasses was used as a common substance in baking and in everyday life. In tea, molasses was used as a sweetener. It is included in several medical remedies. As a meal, molasses can also spread on bread. It can also use as a meal substitute. Molasses can fill your hunger when there is nothing to eat [4]. From many years before, it is known that Sugar cane have a "Sweet Flavor". By evaluation of the Flavoring characteristics it was shown that the presence of Butyric, Syringic, Acetic and Benzoic Acid gives sweet flavor to the sugar cane molasses. In present years, we have also found that the presence of Phenol, Vanillic acid, m-cresol, Anisole, Salicylic acid and resorcinol also give sweet flavor to sugar cane molasses. Some of these compounds indirectly give sweet flavor to it. Recent researchers isolate the odoriferous substance from Sugar cane molasses which is 2 deceno 5 lactone [5].

Maple syrup

A natural sweetener i.e. Maple syrup is formed via boiling of liquid obtained from *Accersaccharumlinn* (Sugar Maple) tree and its other species. Commercial formation, in large scale of maple syrup found in Canada (its Quebec province), United states and North America of east. Majority of Maple syrup supply in world occurs in Quebec province of Canada which is 80%. Maple syrup is extensively used food item. It has a variety of Macronutrient and Micronutrient constituents. In maple syrup, the major Carbohydrate constituent present is Sucrose (Ranging from 60-66%) with other complex

carbohydrates like Fructose and Glucose which are found in lesser quantity. It also has higher molecular wt. polysaccharide. Maple syrup has some minerals like Ca, Na, Al, Fe, K, Mg, Al and Fe, Vitamins like Thiamine, Riboflavin and Niacin etc, Organic acids like Malic acid and Fumaric acid, amino acids like threonine, Proline and Arginine etc&Phytohormones like Phaseic acid and Absciscic acid [6].

Maple Syrup as a Flavorant

Maple syrup has a characteristic flavor of Maple. There are various flavoring compound present in Maple syrup like Pyrazines, Primary Phenolic substances, & Carbonyl substances. The presence of these compounds confirms the presence of Reducing sugar, soluble lignins, Sucrose and Nitrogen containing compound in Maple syrup[7] [8].

Identification of Maple Syrup Flavorant

By extensive extraction of maple syrup in chloroform separate its Flavorants. This extract is analyzed by Gas Chromatography-Mass spectroscopy (GC-MS). Then various un-identified flavoring compounds were detected in high amount. Amongst these aromatic substances there are Guaiacyl acetone, Vanilloyl methyl ketone and acetovanillone. These aromatic compounds were formed by ligneous material ethanolysis which was formerly found in maple syrup. Degradation products of sugar in maple syrup was Hydromethylfurfural, Furfural, Levulinic acid and lactic acid. These substances give flavor to the maple syrup [8][9].

Coconut Sugar

Cononut sugar is a sweetener. It is brown in color. From centuries, Coconut sugar is used by South-East and South Asian. Traditionally, it was utilized to

form Sauces and Sweets because of its specific sweet taste and aroma. Sugar of Coconut is formed from liquid obtained from the closed coconut. Coconut is an significant palm family member. Coconut liquid has high consistency of Protein, 9% sugar, Vitamins and minerals. In the course of preparation of coconut palm sugar, coconut liquid sieved in a pan and it is heated on wood oven. The heating is continued till the required Color and aroma produced. During the coconut palm liquid heating procedure two reactions occur i.e. Caramelisation and Maillard reaction. These two reactions are required for formation of Volatile substances which provide specific flavor to Coconut sugar. In a study 27 Volatile substances of coconut sugar are identified by Gas-Chromatography mass-Spectroscopy. These volatile substances are Acetic acid, 2-nonanonone, 2-Undecanone, 2-furfural, dodecanoic acid and decanoic acid. These substances give sweet flavor to coconut sugar. Characteristic flavor of Coconut sugar had made it a flavoring agent which is used in Baking product and in the preparation of sweets [9].

Agave Nectar

Agave nectar is formed through the juice found in Agave core. It is a juicy plant and native of Mexico. From the agave whole fruit juice is extract out then it is filtered and heated then hydrolyzed to agave sweet syrup. Vegetarians use agave as a substitute of honey. It has high quantities of Calcium, Iron, Magnesium and Potassium. In many food stores of natural product it is used for baking. In agave syrup, amount of fructose is highest than Corn syrup's high fructose content. According to various researches high fructose content of agave syrup is linked to weight gain around abdominal area. Resistance of insulin, high levels of triglycerides and certain heart

diseases. Corn syrup contains 55% fructose content while agave nectar have much higher amount of fructose which is 90%. Regardless of this agave nectar is a low glycemic index sugar because it has low content of glucose. All of us know that increase physical exercises can leads our body to demands of metabolic energy. Although sports, exercises and physical activities can causes sweating which leads to electrolyte loss and dehydration. Moreover, the body main carbohydrates stored in the form of glycogen in liver, muscle and as glucose in plasma. Sometime these stored glycogen become useless and results in Muscle cramping, fatigue and impairment in mental activities. Although little exercise and movement can cause dehydration and reduced glucose levels particularly in humid and hot climate. There is a beverage consist of Agave nectar, rice syrup, electrolyte and juice of fruits. This beverage is used to overcome electrolyte and carbohydrate loss and to provide hydration [10, 11].

Date sugar

The date palm tree is scientifically known as "*Phoenix dactylifera*" which is derived from greek which mean "Red or Purple finger". It belongs to family "Arecaceae". It is used as a food crop in North Africa and Middle east. From the previous 5 thousand years, it was use by people as an important food item. It is also called Holy tree, bread of the desert and life tree (tree of life). Presently, around hundred million date trees are grown around the world. Out of that growth, ninety percent cultivate in Mena. Annually, in 2008, recorded production of dates in the world was 7.5 million ton. They are not only grown in Mena but also in Australia. Dates occupy huge expansion in land used for its cultivation. Dates have a high scope as a food due

to its economic and nutritional importance. Date fruit sugar constitutes of 6.5% to 11.5% dietary fibers, 2% of ash, 2% of proteins, 1% of fat and antioxidants of phenol (1% to 2%). Changing in chemical constitution of dates will affect their Sensory quality, Industrial use and nutritional importance. Dates seeds and flesh has high amount of phenolic antioxidants and fibers which can be used in the preparation of healthy foods. Date sugars can be used in the preparation of products like jams, date flavored bars, date flour, sugar preparation, as an ingredient in baking, dairy and beverages industry. Date fruit have been utilized as a sweetener of food in various forms like Flour, spreads, and syrups. To acquire sweet taste, it is an intelligent strategy to use fruits instead of added sugar. In order to substitute sugar in food, date fruit sugar is an ideal. Date sugar plays a significant role in everyday nutrition of various individuals living in barren (infertile) areas. Date sugar is an important raw ingredient in the preparation of Industrial and medical ethyl alcohol, protein in edible yeast, yeast in bakery, dates flavored dairy product and citric acid. Date fruit sugar has anti mutagenic and antioxidant activities. It has insoluble fibers such as Pectin, Cellulose, lignin and Hemicellulose which decreases the risk of tumor of bowel and enhances vitality of heart [12].

Xylitol

Xylitol is a substitute for sugar. It is used in the preparation of pharmaceutical and food products because it has benefits for health. It is now produced on large scale by a reduction of chemical which needed highest energy but it is an expensive process. Xylitol's biological conversion requires microorganisms which is an alternate method. This biological conversion is friendly to the environment and cost-effect. This biological process provide high

yield of Xylitol and is more competitive than chemical method.

Xylitol gains the attention of manufacturers of food because its sweetening abilities is like sucrose but it is a low calorie sweetener. It can be taken via people of diabetes. Currently, many products having Xylitol in their formulations are available in the market. Many of them are exclusively manufactured for Insulin-deficiency patients. Xylitol ingestion has many benefits than traditional sugar like it can be used in the prevention & management of infectious diseases. Because of this importance, the xylitol use in food items is greatly expending in market. Xylitol is present as a natural component in various Vegetables, Fruits, Mushrooms, algae and lichens. But in these foods it is present in just small quantities. Which is <1000mg but Xylitol is found in large amount in 300mg to 935mg/ 100gm of dry solids in sources like Cauliflowers, strawberries and Plums. But the amount of Xylitol in these sources vary according to diversity of plants and different seasons.

Xylitol has many benefits than other sweeteners. It has sweetening potential same as Sucrose. So, it may be utilized alone to replace sugar. While other sugars like Mannitol, Arabitol and Sorbitol contain lower sweetening potential than Xylitol and required to be combined with other sugars to gain the required sweet taste. Xylitol can also scattered on Fruits and Cereals. It may be utilized in Baking, Cooking and Salad preparations. Since 1960, it is utilized as a Sweetening agent and additive of food in commercial preparations. Recently, various products having Xylitol is available in the market like Chocolates, Confectionery items, Frozen desserts, Chewing gums, Soft drinks, Ice Creams, Cookies and Chocolates. In chocolates, Xylitol is required as a

substitute for Sucrose. But its high amount in Chocolate will cause a little unpleasant after taste. Whenever Xylitol is used instead of sucrose in making of Chocolates, minor changes will do in the manufacturing procedure. Xylitol is used in these foods to reduce the requirement of strong Sweetening additives. Moreover, Xylitol can be used separately or in combinations with other sweeteners in frozen desserts, Yoghurt and jams to enhance the taste, Color and texture of them. It may be used as a moisturizer, Antioxidant, Cryoprotective, Reducer of freezing point, stabilizer and moisturizer. In ice creams, Xylitol function as Sweetener, Bulking agent and Inhibitor of Crystallization. Xylitol containing ice cream has a soft texture as compared to Sucrose containing ice cream at equal temperature. Xylitol is an excellent humectant in making of muffins and cakes. It absorbs the moisture in product and increases the Shelf life and texture of baking products. It is utilized to completely substitute Sucrose of Sponge cake. Xylitol based products have same properties as sucrose based products [13].

Stevia

Stevia scientifically called *Stevia rebaudianabertoni*, belongs to the family Asteraceae. Stevia is a plant which is used as a Natural sweetener. It is commercially cultivated in Paraguay, Thailand, Brazil, China, Central America, India and Korea. Stevia leaves are used as sweetened glycosides. It is primarily a Sweetening and Flavoring agent in Beverage and food industry. Chemical substances derived from Stevia is the good substitute of sugar and can be used by diabetic patients. Agricultural factors and Climatic conditions altered the quantity and quality of Stevia production. The amount of Phytochemical "Stevioside" is

greater, whenever plant cultivate in long days and when they are collected (harvested) before flowering. Stevia's harvesting time affected by growing season, land and Stevia type. Around the world, stevia is becoming popular for the management of various disorders. It is appropriate for Obese and diabetic patient. Stevia has Antiseptic, Anti-fertility, Antibacterial, Anti-inflammatory, Cardiotonic, Hypotensive and Diuretic. Stevia is a perennial herb. For Centuries, it is used as a biological sweetener and for medicinal applications. This alternate sweetener can used to maintain dental health. Stevia is two-hundred times more sweeter than sucrose. Stevia contains "Steviol glycosides". Steviol glycoside can impart sweet taste. It is a sweetener & Flavor enhancer in Beverage, Food, pharmaceutical and Cosmetics. A clinical research conducted on digestive tract of human shows that stevia constituent "Steviol" would not changed after digestion in high and low amount. It is absorbed unchanged in feces. It indicates that Steviol is the stevia metabolism's final product. This research also shows that various Steviol glycosides after absorption will be glucuronidated in liver. Then new glucuronide passed in liver then passed by kidney. Kidney filtered it in urine. Very small quantity of glucuronide remaining in colon are then excreted by feces. By taking stevia leaves and its extract can decrease the cravings of fat containing foods and sweet. It provides satiety. Thus, used for a weight loss strategy. Stevia is considered as a safe. So, it can be used as a sugar alternative in various foods such as Coffee, Soft drinks, tea, Confectionery, bakery items and ice creams. Company of Coca-Cola wants to use Stevia in their popular brands in order to replace sugars. As compared to Sucrose, the sweetness properties of Steviol glycosides make them to cost-effective alternative which shows that

only a slight change in patient's diet can decrease the risk of health. Investigators are required to do more research on Stevia to find its effect to cure disease and its pathways of metabolism [14].

Risk factors associated with high intake of sweeteners and flavors

There are some risk factors associated with high intake of sweeteners and flavors are following[15].

Diabetes

As per the NHANES (National Health and Nutrition examination survey, the rate of developing diabetes has dramatically increased from 9.8% to 14.3% till 2018. Moreover, western diet leads to increased levels of saturated fats and free sugars increasing incidence of type 2 diabetes. A study proposed mechanism associated with high intake of sweeteners and flavors leading to diabetes is that, in GIT, sweeteners binds with α gustducin and family of T1R sweet taste receptors. Long term use of sweeteners and flavors stimulate receptor of taste and increases secretion of Glucagon like peptide 1 which can increase the nutrient absorption in blood vessels from intestine & enhances GLP 1 production which elevates insulin levels. Therefore, absorption of glucose is increased and leads to type-2 diabetes [16, 17]

Obesity

Obesity rates progressively enhanced in previous four years, increasing high burden on health around the world. Moreover, enhancing rate of obesity among teenagers & children causing health problems. Nowadays, a trend has increased in taking high amount of free sugar rich food, sodium, saturated fats and intake of ready-made food instead of home-made food and processed foods increases

the chances of developing obesity. National Nutrition Survey (NNS) suggested a sweet flavor which is calorie free and as a substitute to decrease BMI, sweeteners and calorie intake in adults & children[18].

Sweeteners & flavors effect on GUT micro-organisms

There are various microorganisms found in human body. These all microorganisms are present in specific environment and lives in community recognized as "Microbiota". Many of these are viruses, protozoans, bacteria and fungi which are found in human GI tract. The composition of these microbiota depends on anthropometric measures, drugs & diet. Microbiota of GI tract have critical functions in dietary fibers fermentation, endogenous intestinal mucous and indigestible substrate. Indigestible substrate fermentation increases specific microbiota growth and break down long chain fatty acids into gases & short chain fatty acids[14]. The intestinal microbiota in humans is significant for health of human & control of disorders. These microbiota plays a part in growth & metabolism. It also plays a part in carbohydrates (indigestible sugar) fermentation. These microbiota work with immunity to combat diseases. Furthermore, these microbiota can boost immunity, improves growth and increases fermentation & metabolism of carbohydrates (unprocessed food).

High intake of sweeteners and flavors in diet can affect GI tract microbiota. National Nutrition Survey suggested that too much intake of sweeteners and flavors can influence intestinal micro-organisms. Nutritionists motivates consumers to take low amount of sweeteners, because they have potential to alter beneficial bacteria in our body. It has

observed that excessive sweeteners and flavors in soft drinks and processed food can convert intestinal beneficial bacteria to pathogenous bacteria and cause blood poison called as “Sepsis” [19].

METHODOLOGY

The review was done systematically of the articles on Natural sweeteners and flavors for this study.

Searching strategy

The literature survey was done from 1st January, 2024 to 24th August, 2025. The search was done by means of keywords “Natural sweeteners and flavors, honey, molasses, maple syrup, coconut sugar, agave nectar, date sugar, xylitol, stevia, GUT microbiota, National Nutrition Survey, obesity, hemorrhage, diabetes and compromising immunity.” in search engines like Google scholar, Web of science, Scoopus and Pub-med. The search was restricted by setting timeframe between 2009 to 2025.

Inclusion criteria

- Literature on Natural sweeteners and flavors in English.
- Reported studies were done on Sweeteners and flavors during past 17 years.

Exclusion criteria

- Studies don't have clear explanation about Natural sweeteners and flavors.
- Studies conducted on Artificial and processed sweeteners and flavors.

Data collection & evaluation

Selection of literature based on abstracts and complete articles on natural sweeteners and flavors.

Data extarction

The below mentioned data from each article were evaluated and noted:

- General introduction of natural sweeteners and flavors
- Classification of natural sweeteners and flavors
- Types of natural sweeteners and flavors
- Risk factors associated with high intake of natural sweeteners and flavors[20]

RESULTS

The searched literature resulted in 365 best-suited articles on title. Out of which 23 meet the searched criteria. The study evaluated different aspects of natural sweeteners and flavors like their classification, different types like honey, molasses, maple syrup, coconut sugar, agave nectar, date sugar, xylitol and stevia and some risk factors associated with too much consumption of natural sweeteners and flavors.

CONCLUSION

It has been concluded that natural sweeteners and flavors are good for enhancing flavors of food but studies have shown that their excessive consumption can cause a number of chronic disease like diabetes, cancer, obesity and cardiovascular diseases. It can also affect GUT microbiota leading to compromising immunity and decrease in metabolic processes. This can be treated by changing life style of patient by doing dietary changes. National Nutrition survey suggested to avoid artificial sweeteners and flavors and to take natural flavors in low amount. Excessive amount of

both artificial and natural flavors can be hazardous for human health all over the world.

Declaration of conflict of interest

The authors declare no conflict of interest, financial or otherwise. No artificial writing assistance was utilized in the production of this manuscript.

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