

Review Article

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Natural Fruit Sugars and Human Health: A Reality

Sadhana H Upadhya¹, Ganavi HS¹, Veda S N² and Thakur MS^{1,2*}

¹Department of Chemistry

²Centre for Nanomaterials and MEMS

*Corresponding author

Thakur MS, Department of Chemistry and Centre for Nanomaterial's and MEMS, Nitte Meenakshi Institute of Technology, Yelahanka, Bangalore - 560064; India; E-mail msthakur@yahoo.com

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Abstract

Natural fruits and fruit juices are sources of many essential nutrients and provide nutritional value for human health. Fruit juices also contains antioxidants predominantly polyphenols, oligosaccharides, fiber and nitrate, which are very useful for human health may induce a prebiotic-like effect. Many research articles recently reported that consumption of large quantity of natural fruits and fruit juices containing glucose, sucrose and fructose which might counteract the health benefits. Commonly reported health risks are CVD (Cardiovascular diseases), obesity, Diabetes, Alzheimer's, Cancer, and Liver Disease. Thus this article summarizes the effect of intake of natural sugars on nutrition and human health. The consumption of sugars and its relation to health issues are the subjects of considerable debate and controversy.

Several prospective studies have been conducted to examine the relationship between fruit juice intake and risk of incident type 2 diabetes, but results have been mixed. In the present study, we aimed to estimate the association between fruit juice intake and risk of type 2 diabetes.

Keywords: Natural Fruits, Fruit Juices, Diabetes, Glucose, Fructose, Sucrose, Galactose, Maltose.

Introduction Fruits and Fruit Juices

Fruits are universally considered as healthy and tasty. The Dietary Guidelines for Americans 2010 suggested one-half of plate must include fruits in their diet. The content of energy and nutrients vary significantly in different fruits [1]. A fruit contains high antioxidant and fiber but relatively low energy density and low glycemic load. Additionally, a fruit includes various bioactive components, such as vitamins, minerals, carotenoids, folates, flavonoids, and polyphenol, which are considered to be beneficial in insulin sensitivity [2]. Most of the fruits contain a comparatively high concentration of sugar (i.e., fructose), which has been directly linked to impaired pancreatic β -cell function in humans [3]. Other sugars such as glucose, sucrose, galactose, and maltose present in fruits which provides required energy to the body to achieve physical and mental functions. The overall health effect depends on the individual's consumption level of whole fruit and also effected by consuming mixture of different bioavailable compounds present in fruits [4,5].

The bioactive components present in fruits which are essentially converted to pressed juice or into puree during processing [6]. Fruit juices are turbid or clear extractable fluid obtained by the mechanical process from ripe fruits provide vitamin C, folate, potassium and other micronutrients. Other than nutrient content, fruit juice includes antioxidants such as anthocyanin, catechin and phenols [7]. The freshly squeezed fruits canned or bottled which is composed of one or more fruits with no added sweeteners or sugars are considered as 100% fruit juice [6,8,9]. Although composition of fruit juices is different from that of whole fruits, they contain polyphenols and vitamins from fruits. Many studies have revealed that consumption of whole fruit lowers the risk of several chronic non communicable diseases such as cardiovascular diseases, cancer, chronic respiratory diseases (i.e. chronic obstructed pulmonary disease and asthma), chronic kidney disease, osteoarthritis, osteoporosis, cataracts, Alzheimer's and diabetes mellitus [10]. Diabetes has exploded in a majority of areas in the world [11]. The epidemiological studies revealed that on consumption of fruit alone, lower the risk of diabetes, obesity, hypertension, and cardiovascular diseases, whereas intake of fruit juices increased the hazard of diabetes among women and through worldwide type 2 diabetes has increased quickly with increases in obesity.

A study conducted in 2000 by the researcher, reported that the number of people suffering from diabetes mellitus throughout the worldwide was 171 million, and this number is predictable to increase nearly 366 million by the year 2030 [12].

Fruits and Fruit Juices and Health Impact

Fruits and fruit juices are source of many essential nutrients; also these fruit juices provide sufficient energy. Fruit juices with high sugar level can cause increase in blood sugar levels and may lead to hyperglycemia (too high blood sugar levels). The Glycemic Index (GI) gives an analysis of carbohydrate content in food which increases blood sugar levels of individual foods. The GI varies for fruits and fruit juices. The GI of juices is placed between 66 and 76 on a scale of 100 considered as high GI drink. High GI drinks should be avoided by people suffering from diabetes [13].

Recent study revealed that orange juice is a good source of many nutrients such as vitamin C, folate, potassium and Vitamin B1. It also includes antioxidants which increase the antioxidant value of the blood. The major disadvantage of fruit juices is that they contain very low fiber with very high concentration of sugar [14]. A glass (250ml) of unsweetened orange juice gives about 100 calories as compared to 60 calories in whole fruit. Fruit juice contains more sugar than the World Health Organization recommends ideally having in a day (30g of sugar for men, 24g for women) [15]. In general, 355 ml orange juice contains 10 teaspoons of sugar which is almost similar in quantity of sugar in Coke [16].

Researchers also found that drinking apple juice before meal increased appetite and one consumed more food/calories than those who only ate an apple fruit. Children who drink juice instead of eating fruit may consume more food in a day due to increase in appetite. Excessive consumption of juice has been linked to an increased risk of obesity and cavities in children. It is also reported that sugar consumption increases blood pressure and cholesterol levels. A recent study suggested that sugary drink consumption and premature cell aging have link between fruit juice and longer telomeres. Telomeres are protective DNA on the end of cell chromosomes. Longer telomeres have been linked to insulin resistance and diabetes [13].

Diabetes Mellitus

Diabetes or diabetes mellitus is a metabolic disorder where the patient suffers from high level of glucose in blood. High glucose concentration in the blood is caused due to deficiency in insulin producing pancreatic beta cells, known as type 1 diabetes or insulin resistance and the condition where the body cells are not able to use insulin produced by the pancreas is known as type 2 diabetes in this condition blood sugar level increases very fast due to high quantity available sugar in fruit juices. Therefore, diabetic patients should avoid drinking fruit juices. Generally, consuming whole fruit is healthier than drinking fruit juices, fruit salad and fruit smoothies. Recently it is reported that regular consumption of fruit juice may increase the risk of developing type 2 diabetes [17].

It is most essential to treat both types of diabetes and to reach normal blood glucose and blood pressure levels. In this review an attempt has been made to achieve healthy lifestyle, to improve the well-being of the patients, to focus on traditional uses and their multivalent actions as being health promoting, as well as putative therapeutic agents, especially in diabetes mellitus to protect them against longterm damage to the eyes, kidneys, nerves, heart, and major arteries. Regular consumption of fruits, vegetables, and dietary spices will limit the harmful effects of them and also influence various systems in the body, with diverse metabolic and physiological actions. Fruits play a crucial role in reducing various chronic diseases and also in the management of diabetes mellitus [11].

A study conducted in 2013 experts from the UK, Singapore and a team from Harvard School of Public Health in the US have examined that certain fruits impact type 2 diabetes, which have affected more than 3,000,000 people in Britain. The study suggested that having three portions of fruit juice a week was associated with an eight percent increase in diabetes risk. In year 2013 Harvard School of Public Health reported that consumption of fruit juices are more risky than the whole fruit for T2D (type 2 diabetes). Researchers reported that people who ate at least two servings each week of certain whole fruits such as blueberries, grapes, and apple found that reduced their risk for type 2 diabetes by 23 percent as compare to those who ate less than one serving per month. It is also reported that those who consumed one or more servings of fruit juice each day increased their risk of developing type 2 diabetes by as much as 21 percent. The fruits glycemic index did not prove to be a significant factor in determining a fruit's association with type 2 diabetes risk. However, the high glycemic index of fruit juice has the positive link between juice consumption and increased diabetes risk [18].

A study conducted by Basu et al 2013, mentioned that consumption of soft drink was significantly linked with obesity and diabetes, High consumption of soft drink poses a global public health risk of worsening obesity and diabetes [19]. "Unacceptably high" levels of sugar are found in fruit juices, smoothies and fruit drinks [20]. Whereas consumption of green leafy vegetables and fruits were associated with a lower hazard of diabetes [21]. Recently it is reported that intake of 100 % fruit juice does not have a significant effect on glycemic control or measures of insulin resistance [22]. A number of potential health risks and health benefits that are associated with the consumption of fruit juices and their products have received extensive attention from both in public and scientific forums cautioning the use of fruit juices and related products [23]. Consumption of 100% natural fruit juice is associated with better nutrient intake and diet quality. Diet quality is positively associated with 100% natural fruit juice consumption in children and adults in the United States [24]. In children, excessive fruit juice consumption has been associated with an increased caloric intake and obesity [25].

Researcher suggests that pre-pregnancy higher consumption of whole fruits is not associated with increased GDM (Gestational diabetes mellitus) risk. The association of fruit juices with GDM risk appears to be nonlinear, with the lowest risk being among women with modest consumption [26].

Sugars in Fruit Juices

The major natural sugars present in fruit juices are glucose, fructose, and sucrose and in small amounts it includes galactose and maltose. Some of the dried fruits such as mango, raisins, peaches, dates, figs, apricots, grapes, and watermelon and kiwi fruits contain very high concentration of sugars. Sugar content in fruits, dried fruits and fruit juices are given in table 1 [27].

Table1: Composition and sugar content in fruits, dried fruits and fruit juices (Grams sugar per 100 grams)				grams)		
Fruits and dried fruits	Total sugars	Glucose	Galactose	Fructose	Sucrose	Maltose
Dried mango	73					
Raisins, Golden	70.6	32.7		37.1	0.8	
Raisins	65	31.2		33.8		
Dates	64.2					
Dried figs	62.3	26.9	3.9	24.4	6.1	
Dried papaya	53.5					
Dried pears	49					
Dried peaches	44.6	15.8		15.6	13.2	
Dried prunes	44	28.7		14.8	0.5	
Dried apricots	38.9	20.3		12.2	6.4	
Grapes	18.1	6.5	0.4	7.6		0.1
Banana	15.6	4.2		2.7	6.5	
Mango	14.8	0.7		2.9	9.9	
Cherries, sweet	14.6	8.1		6.2	0.2	1.3
Apples	13.3	2.3		7.6	3.3	
Pineapple	11.9	2.9		2.1	3.1	
Purple Passion Fruit or Granadilla	11.2	4		3.1	3.3	
Kiwi fruit	10.5	5		4.3	1.1	
Pear	10.5	1.9		6.4	1.8	
Pear, Bosc	10.5	1.9		6.4	1.8	
Pear, D'Anjou	10.5	1.9		6.4	1.8	
Pomegranate	10.1	5		4.7	0.4	
Raspberries	9.5	3.5		3.2	2.8	1
Apricots	9.3	1.6		0.7	5.2	3.1
Orange	9.2	2.2		2.5	4.2	
Watermelon	9	1.6		3.3	3.6	
Cantaloupe	8.7	1.2		1.8	5.4	
Peach	8.7	1.2		1.3	5.6	
Nectarine	8.5	1.2			6.2	
Jackfruit	8.4	1.4		1.4	5.4	
Honeydew melon	8.2					
Blackberries	8.1	3.1		4.1	0.4	
Cherries, sour	8.1	4.2		3.3	0.5	
Tangerine	7.7					
Plum	7.5	2.7		1.8	3	
Blueberries	7.3	3.5		3.6	0.2	
Starfruit	7.1	3.1		3.2	0.8	0.1
Elderberries	7					
Figs	6.9	3.7		2.8	0.4	
Mamey Apple	6.5	1.1		3.7	1.6	
Grapefruit, pink	6.2	1.3		1.2	3.4	
Grapefruit, white	6.2	1.3		1.2	3.4	
Guava	6	1.2		1.9	1	0.7
Guava, strawberry	6	1.2		1.9	1	

Рарауа	5.9	1.4	2.7	1.8	0.4
Strawberries	5.8	2.2	2.5	1	
Casaba melon	4.7				0.3
Tomato	2.8	1.1	1.4		
Lemon	2.5	1	0.8	0.6	
Avocado, California	0.9	0.5	0.2	0.1	
Avocado, Florida	0.9	0.5	0.2	0.1	
Lime	0.4	0.2	0.2		

Fruit/Fruit Juices and Glucose

The major critical sugar for diabetics is glucose, which is the common form of carbohydrate found in food, fruits and vegetables. Increase in blood sugar level takes place when starchy material are converted in the form of glucose during digestion and supplies energy to the body [28]. Glucose is also a known dextrose, one of the group of carbohydrates known as simple sugars. Naturally glucose is found in fruits and honey. It is the main source of energy for cell function and the regulation of its metabolism. In intestinal tract glucose is broken down, which increases the blood sugar level in the body. Blood sugar in the body is maintained to a normal level on release of insulin in the pancreas which is a storage hormone. The insulin binds to the glucose and carries it to the cells. Cells that need glucose have insulin receptors that allow glucose to enter to efficient utilization of glucose. Problems arise when glucose is continuously high. Consuming high starch containing processed foods such as white flour, white rice, foods containing sugars, regular intake of high sugar fruits and fruit juices increase blood glucose very high. For some instance, the pancreas can handle this workload, over time pancreas becomes exhausted and unable to release insulin efficiently. This condition resulted in raised blood glucose levels

found in type 2 diabetes or metabolic syndrome. At the same time, because insulin release is inefficient, glucose is not delivered to the cells that needed for metabolism, thus cell starvation occurs. Hyperglycemia has been related to:

High levels of blood lipids, Obesity, Heart attack and stroke, Poor wound healing, Decreased Immunity, Kidney failure, Nerve damage, Peripheral nerve disease [29].

Consumption of high glucose on regular basis increases glucose content in the blood and production of insulin in pancreas may decrease rapidly which may affect brain function, including mood and fatigue and also risk of cardiovascular (heart) disease [30].

After consuming high glucose foods, fruits and fruit juices many changes occur in the liver which produces very low density lipoproteins (VLDL) that causes cardiovascular disease in our body. However, about 1 out of 24 calories of the glucose we consume is processed in the liver and rest gets converted into VLDL [31]. Sugars especially glucose in fruit juices can increase blood sugar level significantly.

Fable 2: G	lucose content i	n Some F	Truits and	Fruit Juices
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Sl.no	Fruits	Glucose (mg)
1.	Apricots, dried, sulfured, uncooked	Glucose: 27454mg
2.	Pineapple, canned, juice pack, solids and liquids	Glucose: 25663mg
3.	Dates, medjool	Glucose: 24322mg
4.	Pomegranate juice, bottled	Glucose: 23253mg
5.	Grape juice, canned or bottled, unsweetened, with added ascorbic acid	Glucose: 22700mg
6.	Plums, raw	Glucose: 22046mg
7.	Cherries, sour, red, canned, water pack, solids and liquids (includes USDA commodity red tart cherries, canned)	Glucose: 21667mg
8.	Guanabana nectar, canned	Glucose: 21597mg
9.	Plums, dried (prunes), uncooked	Glucose: 21219mg
10.	Cherries, sweet, raw	Glucose: 20921mg
11.	Grapes, red or green (European type, such as Thompson seedless), raw	Glucose: 20867mg
12	Mango nectar, canned	Glucose: 20821mg
13	Tamarind nectar, canned	Glucose: 20774mg
14	Guava nectar, canned	Glucose: 20528mg
15	USDA Commodity, mixed fruit (peaches, pears, grapes), canned, light syrup, solids and liquids [Commodity code A404]	Glucose: 20469mg
16.	Figs, dried, uncooked	Glucose: 19911mg
17	Blueberries, canned, light syrup, drained	Glucose: 19588mg
18	USDA Commodity, mixed fruit (peaches, pears, grapes), canned, light syrup, drained [Commodity code A404]	Glucose: 19263mg
19.	Pineapple, canned, heavy syrup pack, solids and liquids	Glucose: 19232mg

20.	Cherries, sweet, canned, pitted, heavy syrup pack, solids and liquids	Glucose: 19109mg
21.	Blueberries, wild, canned, heavy syrup, drained	Glucose: 18938mg
22.	Raisins, seedless	Glucose: 18564mg
23.	Pineapple juice, canned, unsweetened, with added ascorbic acid	Glucose: 17550mg
24.	Pineapple juice, canned, unsweetened, without added ascorbic acid	Glucose: 17550mg
25.	Prune puree	Glucose: 17331mg
26.	Pears, canned, light syrup pack, solids and liquids	Glucose: 16843mg
27.	Cherries, sour, red, raw	Glucose: 16719mg
28.	Pears, canned, heavy syrup pack, solids and liquids	Glucose: 16489mg
29.	Melons, honeydew, raw	Glucose: 14893mg
30.	Juice, apple and grape blend, with added ascorbic acid	Glucose: 14879mg
31.	Cranberries, raw	Glucose: 14261mg
32.	Dates, degletnoor	Glucose: 14092mg
33.	Apples, raw, without skin	Glucose: 13542mg
34.	Kiwi fruit, (Chinese gooseberries), fresh, raw	Glucose: 13477mg
35.	Juice, apple, grape and pear blend, with added ascorbic acid and calcium	Glucose: 13464mg
36.	Pears, canned, juice pack, solids and liquids	Glucose: 13199mg
37	Pears, canned, water pack, solids and liquids	Glucose: 13106mg
38	Blueberries, wild, frozen	Glucose: 13059mg
39	Abiyuch, raw	Glucose: 13043mg
40	Strawberries, raw	Glucose: 12437mg
41	Strawberries, frozen, unsweetened	Glucose: 11540mg
42	Currants, red and white, raw	Glucose: 11499mg
43	Apple juice, canned or bottled, unsweetened, with added ascorbic acid	Glucose: 11437mg
44	Apple juice, canned or bottled, unsweetened, without added ascorbic acid	Glucose: 11437mg
45	Bananas, raw	Glucose: 11190mg
46	Applesauce, canned, unsweetened, with added ascorbic acid	Glucose: 10955mg
47	Blackberries, raw	Glucose: 10742mg
48	Peaches, dried, sulfured, uncooked	Glucose: 10735mg
49	Watermelon, raw	Glucose: 10534mg
50	Orange juice, frozen concentrate, unsweetened, diluted with 3 volume water	Glucose: 10399mg
51	Peaches, raw	Glucose: 10000mg
52	Orange juice, canned, unsweetened	Glucose: 9662mg
53	Oranges, raw, navels	Glucose: 8040mg
54	Tangerines, (mandarin oranges), raw	Glucose: 8038mg
55	Pineapple, raw, traditional varieties	Glucose: 7824mg
56	Grapefruit, raw, pink and red, all areas	Glucose: 7667mg
57	Raspberries, raw	Glucose: 7155mg
58	Nectarines, raw	Glucose: 7137mg
59	Pineapple, raw, all varieties	Glucose: 6920mg
60	Clementine, raw	Glucose: 6766mg
61	Pineapple, raw, extra sweet variety	Glucose: 6667mg
62	Lime juice, raw	Glucose: 4800mg
63	Avocados, raw, Florida	Glucose: 3617mg
64	Rowal, raw	Glucose: 1982mg
65	Avocados, raw, all commercial varieties	Glucose: 463mg
66	Avocados, raw, California	Glucose: 96mg

Fruits/Fruit Juices and Fructose

Fructose is another major sugar present in fruit juices. Fructose is a monosaccharide carbohydrate similar as glucose having different structural configuration. It is often known as "fruit sugar." Consumption of fruits with more than 4 grams of fructose is considered 'high in fructose. The high-fructose containing fruits are apples, cherries, mangoes, watermelon and pears. Most of the dried fruits like grapes, apples, pears, cherries, pomegranate, kiwi and blackberries contains very high amount of fructose. Fruits with moderate level of fructose content include avocados, cranberries, apricots, and clementine. Similarly in India Kinnow hybrid orange is grown in Punjab, which has good nutrition value having glucose (4.6%), sucrose (3.9%), fructose (9.8%), arabinose (1.4%) in dried pulp [32].

The moderate amounts of low-fructose fruits, is found in honeydew melon, cantaloupe, bananas, blueberries, strawberries and oranges.

Fructose is processed by the liver and it was suggested that a diet including high fructose content may affect the liver, and may cause several health issues such as non-alcoholic fatty liver disease and type 2 diabetes. Most of the people have sugar in their diet as sucrose which is made up of 50% fructose and 50% glucose. Hence sucrose includes fructose which in turn affects the liver.

High consumption of fruit juices or having fruit juices in addition to high sugar content in their diet may lead to various health disorders. Fruits, dried fruits and fruit juices including high amount of fructose is given in table 3 [33].

Many studies has exposed that consuming too much sugar can harm the liver, increase insulin resistance, and can lead to metabolic syndrome and conditions such as diabetes and obesity. Many research studies have also revealed that fruit juices containing high fructose may increase the risk of non-alcoholic fatty liver disease, and leads to cirrhosis or liver cancer.

Fruit juice and dry fruits	Quantity	Fructose content
Raisins, seedless	1 cup, packed	48.97g
Figs, dried	1 cup	34.17g
Dates, degletnoor	1 cup, chopped	28.75g
Prunes (dried plums)	1 cup, pitted	21.66
Peaches, dried	1 cup, halves	21.58g
Grape Juice, unsweetened	1 cup	18.62g
Apricots, dried	1 cup, halves	16.21g
Pomegranate juice	1 cup	15.86g
Jackfruit	1 cup, sliced	15.16g
Sapote, mamey	1 cup pieces	13.40g
Grapes, red or green	1 cup	12.28g
Bananas	1 cup, mashed	10.91g
Cranberries, dried, sweetened	0.25 cup	10.78g

Table 3:	Fruits a	nd Fruit	Juices	Highest in	Fructose
I able o.	I I UIUS U	ing right	ources	Ingnese m	I I uccose

Cherimoya	1 cup pieces	10.05g
Pineapple juice, unsweetened	1 cup	9.52g
Persimmons	1 fruit (2-1/2" diameter)	9.34g
Pears	1 cup slices	8.99g
Kiwi	1 cup, sliced	7.83g
Mangos	1 cup pieces	7.72g
Cherries	1 cup, with pits	7.41g
Apples, with skin	1 cup	7.38g (6.63g without)
Blueberries	1 cup	7.36g
Feijoa	1 cup	7.17g
Grapefruit juice	1 cup	7.16g
Orange Juice	1 cup	5.55g

On intake of high fructose fruit juices it passes through intestine and are absorbed, during this process fructose does not stimulate pancreas as it does not require insulin as glucose does. Thus fructose directly enters the liver and gets metabolized and rapidly broken down in the glycolytic pathway and then enters in Krebs cycle. Any extra energy from fructose along with other sugars gets converted into glycogen, lactate and fatty acids. Recently attention has been focused on the relationships between excessive dietary sugars, on the obesity, diabetes, metabolic syndrome and cardiovascular diseases. The mechanisms typically proposed for adverse metabolic effects relate to activate lipogenesis, hepatic and extra-hepatic insulin resistance, hyperuricemia and oxidative stress. A recent meta-analysis considered the effects of high doses of fructose on post-prandial triglycerides which indicated significant increase in triglyceridaemia compared with a basic controlled diet. It is suggested that the high post-prandial lipids is caused by excess calories not due to fructose specifically. Consumption of high fructose doses provides excess calories may cause an increase in body weight. It is likely that adding fructose to the diet promotes glucose tolerance by triggering net liver uptake of glucose [34].

According to the American Journal of Clinical Nutrition, fructose intake has increased dramatically in the past few decades. It is reported that on consumption of high level of its concentrated form (crystalline fructose, high-fructose corn syrup), it causes heavy toxic load to liver, resulting in scarring conditions (figure1). Additionally, fructose is converted to glycerol by the liver, which in turn increases the amounts of triglycerides. Accumulations of high triglycerides are linked to high risk of atherosclerosis and heart disease. According to the AJCN article it is reported that, "hepatic (liver) metabolism of fructose thus favors lipogenesis." Hence intake of high fructose has been associated with increased levels of circulating blood lipids which leads to obesity, fat around the middle, lowered HDL, increased levels of uric acid (associated with gout and heart disease), liver scarring (cirrhosis), and fatty liver [35].



Figure 1: Effect of fructose on the liver and kidney

The formation of advanced end glycation (AGE) products, which can lead to signs of aging. Some studies show that fructose creates AGE's up to 10 times more efficiently than glucose Thus it is suggested that a little fruit is just fine – it contains small amounts of fructose the body can easily metabolize. Concentrated fructose in HFCS should be avoided [36].

Fruit Juice and Sucrose

Table sugar is also known as sucrose which is disaccharide molecules contains equal amount of glucose and fructose normally present in ripe fruits. High quantity of Sucrose is found in mangoes, bananas, jack fruit and nectarines. A 100-gram bananas serving includes 6.5 grams of sucrose, whereas mangoes of same quantity have 9.9 grams per serving. Nectarines contain 6 grams of sucrose per 100 grams. Content of sucrose in fruits was found more than 5% in mango, nectarines, bananas, apricots, jackfruits and peaches. Very high concentration of sucrose was found in dates, dried peaches and dried apricots (Table 1). Gibson et al., have reported that intake of sucrose at 25% level does not affect carbohydrates metabolism [37], whereas Truswell reported that more than 30% sucrose intake effect the lipid parameters [38].

Sugar levels and composition were determined in developing 'Hakuto' peach (Prunus persica Batsch var. vulgaris Maxim) fruit. During the early stage of development approximately equal amounts of glucose and fructose were detected. Sucrose is the major sugar in ripe fruit which consequently began to accumulate. As sucrose accumulation is high, concentration of glucose and fructose increases promptly in fruits which leads to various disorders directly or indirectly to the human body. Throughout the development of fruit sorbitol remained in lesser amount. The increase in the concentration of sucrose was accompanied by a rapid increase in sucrose synthase (EC 2.4.1.13) activity [39].

The results documented that deleterious metabolic effects were observed in patients with non-insulin-dependent diabetes mellitus

NIDDM (noninsulin-dependent diabetes mellitus) after consumption of low-fat, high-carbohydrate diets, with moderate amounts of sucrose, similar in composition to the recommendations of the American Diabetes Association (ADA) [40].

Jiang et al., reported that intake of sucrose in mice comparable to levels of Western diets led to increased tumor growth and metastasis, when compared to a non-sugar starch diet. The high amounts of dietary sugar in the typical Western diet may increase the risk of breast cancer and metastasis to the lungs [41].

Kearns et al., reported that sucrose might be associated with heart disease and bladder cancer [42]. Consumption of high-sugar foods stimulates insulin production, which has been associated with endometrial cancer. Although a relationship between sucrose, high-sugar food consumption, and endometrial cancer risk is biologically plausible, this hypothesis has previously been explored by Friberg et al., [43].

Excess sugar consumption has been linked with Alzheimer's disease (AD) pathology in animal models [44]. Consuming two sugary drinks per day aged the brain two years compared to those who didn't drink. Author explains he measured fruit juice intake, he is not sure that sugar alone is what affects brain health.

Fruit Juice and Maltose

Common high maltose fruits include Pears (5136mg), mixed fruit (peaches, pears, grapes) 2763mg, Guava nectar, canned (2596mg), Mango nectar, canned (2196mg) etc. Kiwi fruit, (Chinese gooseberries), fresh, raw contains 623mg of Maltose, Watermelon, raw includes 400mg of maltose, Banana raw contains very less amount of maltose (22mg). Maltose is a disaccharide made from two glucose units. Maltose requires less insulin as compare to glucose. Thus maltose make slightly better energy source for diabetics.

Effect of maltose on the human metabolism was done by Young and Weser (1971). They reported that significant increase in insulin concentration in blood serum after glucose and maltose infusion. It was noted that the maltose administered intravenously has similar metabolic effects as that of glucose. A maltose containing juice or solution provides twice the mass of sugar (and of calories) as an equimolar solution of glucose [45].

Galactose

Galactose is a natural aldohexose almost identical to glucose, but differs slightly in the orientation of functional groups at fourth carbon in structure. For early human development Galactose is the basic source of energy and a fundamental structural element in complex molecules. Recently researchers reported that galactose has beneficial role in a number of diseases, affecting the brain. Galactose play crucial role in human metabolism, energy delivery and galactosylation [46].

Scaman et al 2004 reported that during cold storage, thermal processing of apple slices and during juice processing, by using Gas chromatography free galactose in different varieties of apples such as Braeburn, Fuji, Red Delicious, and Spartan were identified. They reported that Spartan apple had higher level of galactose when compared to Red Delicious apples, during cold storage galactose level increased slightly when preserved for 9 months. By blanching and canning process galactose concentration decreased. Interestingly

during the thermal processing of canning increased the free galactose concentration. An increase in galactose was observed when apple juice was done by enzymatic treatment it is due to its selective action on soluble pectin. These findings provide useful information for dietitian's recommendations for galactosemic patients [47].

Galactose is known to enhance mitochondrial metabolism and could be an excellent model to study mitochondrial dysfunction in human primary myotubes [48]. Galactose is well accepted by diabetic patients by normal individuals and may be used as a source of energy by diabetic patients with less harm than dextrose. Oral galactose is relatively potent insulin promotes secretion [49].

Juice and Diabetes

American Diabetes Association (ADA) suggested that most of the citrus fruit juices such as grapefruit juice, pineapple juice and orange juice are considered to be suitable for diabetic patient if taken in appropriate quantity as they are rich in nutrients. Diabetics can also consume juices which have high fibre, low carbs, low sugar content such as pure apple juice, lemon juice, tomato juice and carrot juice as it is juiced raw. However, all fruit juices contain significant amount of sugar, which lead to increase in blood sugar levels. Therefore, moderate consumption of fruit juices is advised.

Carbohydrates from juices also add to your total intake of sugars for the day. Having juice along with the meal can surely reduce the effects of sugar content of the juice. While citrus juices are low on Glycemic Index table, pineapple and orange juice is rated between 48 to 56and grapefruit juice is rated 48 [50].

Management of diabetes through blood sugar can be done through controlled diet by knowing the glycemic index (GI) of food, fruits and fruit juices. The GI indicate the effect in blood sugar rise by a intake of specific food, less than 10 GI is considered a low effect, and more than 20 is considered a high . Pure 100 percent fruit juice increase less blood sugar and a good source of B vitamins, vitamin C, potassium, phosphorous and magnesium.

Orange Juice

According to Nutrition Data, Orange juice is considered as good for the diabetic patients, as it contains vitamin C (anti-inflammatory), vitamin A, vitamin B1, folic acid (essential for red blood cells) and potassium (essential in muscle contraction).Due to high sugar content in the orange juice it has moderate glycemic index value (about 20 g per 8 fl oz. cup).The USDA Food Guide Pyramid recommends that orange juice is measured as healthy for adults who is suffering from diabetes if it is consumed in limited amount, over consumption of orange juice i.e. more than two cups per day may increase hyperglycemic loads which in turn increase the risk of diabetes.

Apple Juice

Apple juice is one of the healthy fruit juice suggested by the doctors when it is fresh 100 percent fruit juice with no added sugar. Also it provides low caloric value and low GI value than orange juice but it has less vitamin C, A, B1 and potassium, but it is rich in manganese. The fiber component of fruits helps in controlling blood sugar by decreasing its absorption through the duodenum. According to an abstract published in the U.S. National Library of Medicine, there appears to be a connection between ingestion of soluble fiber and reduction of hyperglycemia (high blood sugar) in diabetic patients (non-insulin dependent). To include fiber, purchase apple juice with pulp, or mix apple juice with unsweetened apple sauce.

Grape Juice

Grape juice has the highest sugar components than the other juices (35 g per 236.5 ml), but glycemic index has medium effect. Grape juice provides good amount of vitamin C, thiamine, riboflavin and magnesium, along with chromium. The National Institute of Health has indicated that chromium as a trace mineral has shown positive effects in insulin activity [51].

Factors Diabetics should consider [50].

Blood sugar level increases tremendously on regular consumption of carbohydrates present in natural fruit juices. So few scientist recommended considering the following points by diabetes.

- The volume of a fruit juice or any other drink suggested is 4 oz. per day.
- Regular Consumption of Fruit juices can cause spike more rapidly in blood sugar level.
- The main concern for the diabetic's welfare is added sugar.
- The best choice for the diabetic patients is drinking fruit and vegetable juice prepared with the original pulp. Apple and carrot juices are recommended as the best fruit juices for the patients suffering from diabetes by the Doctors.
- Recommended amount of juices can be taken if there is sudden decrease in blood sugar level as it happens during extreme workout session or fasting.

Carbohydrate content of every juice is different and therefore, the effect of consuming fruit juice on blood sugar level will vary from one fruit to another. ADA also suggests when you drink the juice read the label of a container for the nutritional value and sugar content of the juice, suggests ADA. A juice with no sugar is the first juice for diabetics but is difficult to get such fruit juice drink. Sugar free fruit juices will provide fibers, vitamins and minerals. Dr. Cordain's has advised eating fresh fruits for your appetite good for diabetics. However, if you are overweight or are insulin resistant, it is good to limit high sugar fruits (grapes, bananas, mangos, sweet cherries, apples, pineapples, pears and kiwi fruit) from your diet until your weight comes to normal and your health improves. Try to include more vegetables than high-sugar fruit. Dried fruits contain excessive sugar can be avoided. Note that some fruits (avocados, lemons, and limes) having very low total sugar and should be taken on daily basis [27].

Glycemic Index

GI values specify the level of glycemic response to carbohydrate ingestion and GI values vary among different fruit juices [52, 53]. Glucose has a glycemic index (GI) of 100 and fructose is 25. Sucrose (Ordinary sugar) which is made up of a combination of these two has a GI of 65 [54]. To evaluate whether the GI values affects the association between fruit juice and glycemic control, further investigation showed the effects of GI levels of fruit juices on fasting glucose concentrations. The study indicated that neither low GI fruit juices nor medium GI fruit juices had significantly effect on fasting glucose concentrations. Since no selected RCTs (Randomized Controlled Trials) used fruit juice with high GI as supplement, one could not evaluate the effect of high GI fruit juice on fasting glucose concentrations [52].

Table: 4 List of Sweeteners and its GI value [54]				
Sweetener	Туре	Glycemic Index		
Maltodextrin	Sugar	110		
Maltose	Sugar	105		
Dextrose	Sugar	100		
Glucose	Sugar	100		
Trehalose	Sugar	70		
High fructose corn syrup (HFCS-42)	Modified Sugar	68		
Sucrose	Sugar	65		
Caramel	Modified Sugar	60		
Golden Syrup	Modified Sugar	60		
Inverted Sugar	Modified Sugar	60		
Refiners Syrup	Modified Sugar	60		
High fructose corn syrup (HFCS-55)	Modified Sugar	58		
Blackstrap Molasses	Sugar Extract	55		
Maple Syrup	Natural Sugar	54		
Honey	Natural Sugar	50		
Sorghum Syrup	Natural Sugar	50		
Lactose	Sugar	45		
Cane Juice	Sugar Extract	43		
Barley Malt Syrup	Modified Sugar	42		
Coconut Palm Sugar	Natural Sugar	35		
Maltitol	Sugar Alcohol	35		
HFCS-90	Modified Sugar	31		
Brown Rice Syrup	Modified Sugar	25		
Fructose	Sugar	25		
Galactose	Sugar	25		
Agave Syrup	Modified Sugar	15		
Xylitol	Sugar Alcohol	12		
Glycerol	Sugar Alcohol	5		
Sorbitol	Sugar Alcohol	4		
Lactitol	Sugar Alcohol	3		
Isomalt	Sugar Alcohol	2		
Mannitol	Sugar Alcohol	2		
Erythritol	Sugar Alcohol	1		
Yacon Syrup	Natural Sweetener	1		
Oligofructose	Sugar Fiber	1		
Inulin	Sugar Fiber	1		
Brazzein	Natural Sweetener	0		
Curculin	Natural Sweetener	0		
Glycyrrhizin	Natural Sweetener	0		
Luo Han Guo	Natural Sweetener	0		
Miraculin	Natural Sweetener	0		
Monellin	Natural Sweetener	0		
Pentadin	Natural Sweetener	0		
Stevia	Natural Sweetener	0		

Thaumatin	Natural Sweetener	0
Acesulfame K	Artificial Sweetener	0
Alitame	Artificial Sweetener	0
Aspartame	Artificial Sweetener	0
Cyclamate	Artificial Sweetener	0
Neotame	Artificial Sweetener	0
Saccharin	Artificial Sweetener	0
Sucralose	Artificial Sweetener	0

Conclusion

Fruits and Fruit juices are very good for health but most of the fruits and their juices contain sugars. These sugars such as glucose, sucrose, and maltose contain glucose as one of the component. Thus they have high GI. Therefore fruit containing high glucose should be avoided by diabetics, obesity and obesity-related diseases. Also, the high quantity intake of such high sugar containing or sugar added fruit juices should be avoided in certain age groups, especially children. Like sucrose, the natural disaccharide isomaltulose consists of glucose and fructose, but it is apparently more suitable for people with type 2 diabetes with regard to regulating blood glucose levels. This has now been confirmed in a new study carried out by the German Institute of Human Nutrition (DIFE) [55].

In addition, fruits and fruit juices have good nutrients such as plant fiber and phytochemicals which may be responsible for the antiobesity effects of fruit, but cereals are also rich in phytochemicals and fiber yet they have no remarkable anti-obesity effects.

Furthermore, the anti-obesity properties of known fruit components need to be verified. Thus, future research should be focusing on identifying anti-obesity components in fruit as an urgent and important task in order to understand the scientific mechanism of obesity but also to develop a method for controlling obesity by increasing fruit consumption [56].

Townsend et al., demonstrated that fructose, a common dietary additive in the Western world, decreases the abundance of a regulator of gut colonization in the human gut commensally Bacteroides the taiotaomicron. Dietary sugar silences a colonization factor in a mammalian gut symbiont [57]. Fruit /vegetables are rich sources of several biologically active antioxidants that contribute to general health and decrease the risk of chronic diseases such as cardiovascular disease. They are main source of bioactive phenolic compounds. Polyphenols play a vital role in physiological conditions in vitro including antioxidative, immunomodulatory and antimicrobial activities [58].

Recently it was reported that in older adults, glucose improves cognitive performance by promoting higher cognitive engagement while mitigating the subjective costs of effortful exertion [59]. It was reported that high intake of some of the fruit juices such as apple, cranberry, grape, grapefruit, orange, and pomegranate outcomes linked to cancer, cardiovascular disease, cognition, hypertension, inflammation, oxidation, platelet function, urinary tract infection, and vascular reactivity [60].

Despite the potential benefits of fruit and fruit juices, there are many unanswered questions related to fruit juice and health in humans. There is a strong need for intensive studies for longer duration with well-defined outcomes from intake of fruits and fruit juices.

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