

## Added-sugar: The Silent Perpetrator of Modern Metabolic Disorders

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### SUMMARY

Refined sugar has now become a common sweetener available world over to every strata of the society. Sugar is not only a commodity that has added sweetness in our lives on different festive-occasions, but also a global affordable energy source to vast majority of underprivileged strata of the societies. Ancient Indian physicians have presaged indiscriminate use of sweeten-food preparations, for they had observed such food items precursor of metabolic disorders. Now when modern industrialized and developing-world is getting absorbed with lifestyle related metabolic disorders, has started recognising careless use of sugar-sweeten food and beverages as major contributors to such health issues. Albeit, sugar has now become indispensable food item in our daily life, modern scientific observations caution injudicious consumption of food and beverages prepared with added-sugar. The goal can be achieved through intensive research programs directed to unveil long term harmful effect of such food items and dissemination of knowledge in public.

Our forefathers used to get the taste and pleasure of sweet by eating variety of natural fruits. Fruits were available to them seasonally, full of nutrients required in a particular season. They also had the access of sweet-taste through honey which is still strictly guarded by honey bees. The sweet taste and energy derived from such natural food materials originate primarily from molecules called glucose and fructose. These molecules are the building blocks of sucrose, more popularly known as sugar. Although, the nature has made controlled access of sugar to humans in natural way their body is designed to metabolize and in optimized concentrations required to energize them perform biological activities, the human scientific efforts have made it easily available in the form of refined, crystalline sugar (Lustig *et al.*, 2012).

Historical records disclose that sugar refining and crystallization technology was developed in India way back in around 800 BC (Smith, 1984). Those days, large

amounts of sugar was being exported to China from India during 7th century (Schafer, 1977) until the Chinese ambassador Li I-Piao learned sugar making technique during his stay in Harsa's reign in 647 AD (Devahuti, 1970). Some finds that it was from China, sugar moved towards Persia, North Africa and eventually to Europe in around 11th century (Jabr, 2013) however, some argue that Indian sugar technology had been taken to the West long before its introduction into China (Smith, 1984).

Now, refined sugar has become an indispensable item in our diet. According to a recent estimate, a US citizen consumes an average of 216 L of soda alone per year, of which 58% contains added-sugar (Lustig *et al.*, 2012). This figure does not include consumption of other sugar-sweetened beverages like juices, sports-drinks, chocolates, dairy and confectionary food products. Consumption of such sugar-sweetened food products is increasing unabated in every country, be it the developed or developing nations.

In natural form, sucrose is available in optimized concentration accompanied with number of supporting agents such as electrolytes, minerals, antioxidants and fibres etc. Electrolytes and minerals help maintain physiological buffering capacity and support stabilize biochemical reactions. Antioxidants take care of scavenging free radicals generated during the energetic processes activated by glucose and fructose. Soluble fibres maintain the fabric of biochemical and physiological processes intact.

However, modern industrialized world is craving for refined sugar which is devoid of above accompanying ingredients. The molecule fructose of disaccharide sucrose is sweeter than other molecule glucose (Davies, 2013). For the industrial processing of fructose is cheaper than glucose, economic considerations made USA promote consumption of high-fructose corn syrup 1971 onwards as a sweetener. Now high-fructose corn syrup is commonly employed in processed foods (Winkler, 2012) and soft drinks (Davies, 2013). Over the past 50 years, consumption of sugar has tripled

worldwide. In many parts of the world, it is estimated that people are consuming an average of more than 500 calories per day from added-sugar alone (Lustig *et al.*, 2012).

Refined sugar also serves the purpose of affordable source of energy to the population of many developing and under-developed nations where, food security is still a dream. It is made available to such sections of the societies through public distribution systems at subsidized rates. In fact, in many deprived societies, refined-sugar has become the prime-source of energy. Tea, biscuits and affordable sweetened-confectionary items are consumed heavily in such societies.

On the other hand however, in the wake of emergence of diabetes and hyperglycemic epidemic around the world particularly in younger generations, the increased consumption of food-products with added-sugar has fuelled hot-discussions. It becomes pertinent therefore, to look at the physiological and biochemical effects of consumption of added-sugar contributing to the development of above disorders.

Recent researches disclose that consumption of human-relevant level of added-sugar may be associated with increased mortality in females and lower the male fitness in mice (Ruff *et al.*, 2013). In addition, administration of human-relevant dose of sugar-solution to rats who also consumed regular diet, has been found to induce development of impaired glucose tolerance, reduce plasma total antioxidant potential, increase level of oxidative stress, accelerate formation of advanced glycation end products and disturb the blood coagulation homeostasis by increasing platelets aggregation activity. These physiological derangements were noticed well before development of full-fledged hyperglycemia in rats (Tiwari *et al.*, 2013).

Physiologically, glucose is observed to reduce significantly the blood flow to and activity in specific areas of the brain such as hypothalamus, insula and striatum that regulate satiety, reward and motivation for more food in human. Fructose on the other hand, has little effect on brain regions that curb appetite and hence fails to produce feeling of fullness (Page *et al.*, 2013). It has been noticed that added-sugar interferes with the signalling processes of hunger to the brain by dampening suppression of hormone ghrelin, affect feeling of satiety by interfering normal transport and signalling of leptin hormone, decreases feeling of food derived pleasure and hence, increases the urge to eat more by reducing dopamine signalling in the brains reward centre (Lustig, 2010; Garber and Lustig, 2011).

Sugar is being blamed as precursor for the development of metabolic disorders (Lustig, 2010; Tappy *et al.*, 2010). It has been found to induce

development of hypertension via fructose-mediated increase in uric acid level, provoke hypertriglyceridemia and development of insulin-resistance via increasing synthesis of fat in liver. By promoting gluconeogenesis and insulin resistance, sugar has also been observed to increase incidences of diabetes and accelerate ageing- process through non-enzymatic binding and damage caused to biomolecules such as lipids, proteins and DNA (Lustig *et al.*, 2012).

It is pathetic to mention that 80% of people with diabetes live in low-income or middle-income countries, many of which are still struggling to cope with diseases of poverty such as malnutrition, high maternal and neonatal mortality and infectious diseases. Addition of relentless rise in prevalence of type-2 diabetes along with exponential population growth in these countries is devastating the ill-equipped and fragile public health system (Editorial, 2013). For the efforts of modernization of these countries are in full swing, the introduction of such food items in these nations via modernization and over indulgence of people with modern food-items rich in added-sugar are identified as one of the major perpetrator responsible for emergence of metabolic disorders.

Before the introduction of so-called modernization, population of these countries were relying on traditional-foods. The fundamentals of traditional food was based on incorporation of whole food grains-based dietary preparation, knowing the fact that it will provide 'ordered' energy and promote healing (Michels, 2003). Such fundamental knowledge about food can be traced back in ancient Indian classic 'Taittiriya upanishad' (Sharvananda, 1921) which states that 'food is the eldest of all creatures, for it gives life to all living beings on this earth and hence is superior of all medicaments'. Furthermore, other classical texts of traditional medicines, Indian in particular, criticized the over consumption of and indulgence with refined and processed food items including sweetened-food products and levelled them as diabetogenic food. The verse from *Charak Samhita* (Shukla and Tripathi, 2009) clearly stated that 'over indulgence in and consumption of processed food and sweetened-food products may turn person diabetic over the time. Similarly, verse from *Susruta Samhita* (Murthy, 2012) highlighted the fact that the persons indulged in consumption of beverages and food preparations that are cold; contain fat, sweet and alcohol, are prone to develop diabetes. Statements made in these ancient classics of traditional Indian medicine are now getting approval through modern scientific analysis finding that over indulgence of energy-dense and easily available foods/drinks and sloth are contributing to the so-called diseases of civilisation (Marlene, 2013).

Refined sugar is devoid of its natural supporting agents as present in natural matrix of the fruits. Hence, it may be considered as synthetic sugar. Therefore, its undesirable effects like other synthetic drug or bio-active molecules are obvious. The harmful effects of sugar such as induction of impaired glucose tolerance, reduction in total antioxidant potential in plasma, development of oxidative stress, impaired platelets aggregation activity and formation of advanced glycation end products were found significantly arrested when sugar was administered in vegetables fresh-juice (Tiwari *et al.*, 2013). The fresh-juice of vegetables may mimic natural matrix of fruit-juice containing sucrose and can be held responsible for alleviation of harmful effects of sugar in this report (Tiwari *et al.*, 2013). These explanations find support with recent observations that consumption of sugar-added soft drinks but not the intake of 100% fruits or the vegetables juice is associated with increased risk of type-2 diabetes (Eshak *et al.*, 2013).

Rome realised the health benefits and importance of whole food grains, vegetables and fruits and started Slow Food Movement in 1986 against the promotion and consumption of processed and fast-foods culture. Indians had such realisations some 2600 years ago. That might have been the reason levelling processed foods diabetogenic and advocated whole grain based food preparations as therapeutic to diabetes people (Tiwari, 2008; Tiwari *et al.*, 2012).

Rapid industrialization and technological developments changed lifestyle of modern human away from the natural food. past-paced-high-tech life of modern world led developed countries evolve highly processed fast-energy giving food-products to meet high-calorie requirements of high-tech modern lifestyle now called 'Western lifestyle'. Intrusion of Western culture followed by adoption of Western lifestyle in many traditionally living countries such as India and China is being reasoned for the outburst of cases with metabolic syndrome. The dilemma of such countries is that, they have small portion of population having the privileges of everything in life. However, majority population in these countries is still struggling for food security. It is this vast majority that has become hot-market place for modern food industries to meet their food-energy requirements.

Now, food industries are being blamed and targeted for the ill-health effect of modern food products in societies. Their nexus and lobbying (Davies, 2014) with government is being abused preventing any stringent action against them. On the other hand, it also true that both are huge employment generators and play important role in nation building.

For it is the society that suffers from over consumption of sugar-added food items, extensive and

honest awareness programs about ill-health effect of consumption of food-products with added-sugar may be more beneficial in making society healthy rather than blaming industries, pointing lobbyist and abusing governments. Extensive research programme on ill health-effect of such food products and dissemination of results in public may alert and keep society up to date. These efforts may help bring down epidemic of non-communicable diseases such as diabetes induced by added-sugar consumption in reality.

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