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Review Article

Alternative and Supplementary Health Model on Traditional Sugars

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ABSTRACT

This article reviews nutraceutical properties of traditionally processed sugar products in view of food policy implications in India. This review gains importance in the light of overconsumption of foods rich in sugar, salt and fat, in the recent decades, and the associated epidemic of non-communicable diseases in India and rest of the world. Food policy in India does not signify the traditional sugars. We have presented an alternative health model to analyse nutraceutical properties of traditional sugars and distinguish them from refined sugars. We have evolved this model using ancient health wisdom of India. Traditional sugars are distinct from refined sugars by composition, nutritional benefits, rate of energy release and medicinal values. The traditional sugars are rich in nutraceuticals properties while the refined sugars are of empty calories. Research proofs show that the traditional sugars possess immunological properties, cyto-protective features, anti-toxicity effects and anti-cariogenic characteristics. The traditional products have also been proved to have positive health effects on diabetes and hypertension. Yet, the refined sugar products do not possess such properties. We recommend the policy makers to take action to list the nutraceutical properties of the traditional sugars in international scientific databases. We also suggest the policy makers of India that traditional sugars need to be distinguished from refined sugars in food labeling standards.

Keywords: Traditional sugars; Nutrition transition; Health model; Non-communicable diseases

Key Points: CAM monotherapy for patients with Mycobacterium avium-intracellulare complex (MAC) Lung Disease is not recommended.

Abbreviation: Non-Communicable Diseases (NCDs); World Health Organisation (WHO); High Fructose Corn Syrup (HFCS); Food Safety and Standards Authority of India (FSSAI); Sugar Sweetened Beverages (SSB); United States Department of Agriculture (USDA)

INTRODUCTION

India, in the recent decades, has been experiencing the phenomenon of 'nutritional transition' characterised by increased consumption of food articles rich in sugar and fat coupled with increased inactive behaviour [1]. Ancient dietary principles and practices adopted in the country have declined over the years. Globalization of trade promotes cultivation of cash crops over non-cash food crops in developing countries like India and this result in decline of availability of traditional foods for the local population. Consumers of the developing countries are heavily influenced by free market factors leading to shift from traditional diets to excessive Western-type diets. The recent economic development among the population in India also causes changes in dietary behavior. [2]. These changes in dietary patterns in coincidence with sedentary behavior, psychological stress, pollution and consumption of tobacco products and alcohol in the last one century have caused deterioration of human health and emergence of obesity and Non-Communicable Diseases (NCDs) like cardio vascular ailments, diabetes, cancer, chronic respiratory diseases etc. [1,2]. Traditional sugar products of India, though proven to be nutritionally and medicinally valuable, lost their prominence in the diet of Indian population, in the latest years [3]. Nevertheless, the people, in recent years, have started recognising the ill effects [4] of present-day diets and natural and traditional products are becoming admired. This uncovers new prospects for revival of the traditional sugars [5].

The global society is facing a daunting challenge in tackling the health issues especially the issue related to non-communicable diseases (NCDs). There are many inter-related factors leading to NCDs including a variety of elements of dietary practices and physical activities of human beings. Worldwide, the number of people who are overweight or obese has touched epidemic quantities and these phenomena are directly related to the

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mounting proportion of people suffering from NCDs [6]. A report of World Health Organisation (WHO) published in 2011, states that, in last 100 years, mortality due to communicable diseases has diminished, but the number of people dying due to NCDs has significantly risen [7]. WHO has declared that, by 2023, around 39% people aged 18 years will be overweight and 13% will have obesity problems. Disturbingly, more than 340 million population aged 5-19 worldwide are overweight. In most of the countries, the phenomena of overweight and obesity cause mortality of the people than underweight. India, the second largest populous country in the world, is also amidst the problem. In low and middle income countries, 80% of the deaths were due to cardiovascular diseases and diabetes [8]. In 2017, nearly 73 million adult populations in the country were diabetic which constitutes slightly above 17% of the total people with diabetes in the world [9].

Among the different factors causing obesity and NCDs, consumption of sugar by the people has received a large volume of focus by research community, policy making bodies and civil society organisations. A study by Weeratunga, et al. found out intensely positive and statistically significant correlation 0.660 ($p<0.001$) between per capital sugar consumption and prevalence of diabetes in Asian countries [10]. Sugar is increasingly being over consumed by the populations across the world. The rise in the consumption of sugar has been fuelled by the invention of cheaper source of sugar like High Fructose Corn Syrup (HFCS) in the market [11]. Abundance of sugar has enabled the upsurge in the production and consumption of sweetened food items sugar sweetened beverages, ice cream, chocolate, confectionary etc. These relishing products have however, lead to havoc in the health of the human beings in the recent years [6]. Ironically, sugars had been considered primarily as medicine in the ancient times. The sweeteners had been used sparingly in diet, in olden societies, particularly in India [2]. In early days, sugar had been manufactured using indigenous technologies and still those production methods are adopted by millions of farmers and small scale enterprises [12]. A good number of literatures provide evidence that the traditional sugars possess nutritive and medicinal values [5], while refined sugars do not possess such properties.

Governments and other organisations related to sugar have recently initiated policy and educative interventions to address the problem [13]. Policy actions, across the countries including India, focus only on refined sugars manufactured using modern technology. However, the traditional sugars, which are rich in nutritive and medicinal values, do not, generally, find a place in the policies. The Food Safety and Standards Authority of India (FSSAI), a regulatory body of Government of India, does not recognise the significance of the traditional sugars. As stated by Jaffé, this is primarily attributed to the inadequate documentation of nutritional and medicinal properties of the traditional sugars in scientific databases [5], while sufficiently large number of research and documentation is available in case of refined sugar products.

FSSAI has released a draft guideline recently, which emphasises reducing consumption of foods containing high fat sugar and salt [14]. The agency has circulated a document entitled the Food Safety and Standards (Labelling and Display) Regulations for comments from the stakeholders. Labelling standards that aim at providing information related to availability of sugar that is excess of recommended quantities are described in the document [15]. The document defines sugar as

"Sugar means all monosaccharide's (glucose, fructose, etc.) and disaccharides (maltose, sucrose, lactose, etc.)."

The definition infers that qualities of traditional sugars are not differentiated from the sugar products which are manufactured through refinery processes. The agencies that maintain scientific database do not have any record of nutraceutical properties of the traditional sugars. Purpose of this review article is to present the distinguished features of the traditional sugars using an alternative health model that will enable research community and policy makers to gain new knowledge for future course of action. We, in this article, have made an attempt to consolidate historical and research evidences that prove distinct features of the traditional sugars over the refined sugars. In this article, we begin with a review of literature on health effects of refined sugars has been made. Policy initiatives on addressing the issue of sugar menace undertaken by the governments of India and other countries were followed by this, we introduce a conceptual framework, in which an alternative health model to address the effects of nutritional transition phenomenon is narrated in the next section. Distinct features of the traditional sugars over refined sugars are elaborated in the subsequent section. The article concludes by offering policy recommendations to the Government of India and international agencies.

Definition of terms related to types of sweeteners

For operational understanding, definitions of different types of sugars which are dealt in this article are given in Table 1.

Table 1: Definition of different types of chemical sugars.

Type	Definition
White sugar[a]	Purified and crystallised sucrose with a polarisation not less than 99.7 °Z.
Raw cane sugar[a]	Partially purified sucrose, which is crystallised from partially purified cane juice, without further purification, but which does not preclude centrifugation or drying, and which is characterised by sucrose crystals covered with a film of cane molasses.
High Fructose Corn Syrup[b]	High-fructose corn syrup (HFCS) is a liquid sweetener alternative to sucrose (table sugar) used in many foods and beverages.
	It is made from corn starch that has been processed by glucose isomerase to convert some of its glucose into fructose.
Free sugar[c]	All monosaccharides and disaccharides added to foods by the manufacturer, cook, or consumer; sugars naturally present in honey, syrups, and fruit juices
Added sugar[c]	Sugars and syrups added to foods and drinks during processing and preparation, yet it does not cover honey or fruit juices.
Source: a [16], b [11], c [17]	

Sources of sugars are many. The present article focuses on the above five dimensions of the sugar. The raw cane sugar is also called non-centrifugal sugar (NCS) or traditional sugar. The products of this type are named differently according to the country and regional contexts [5]. In this article, raw cane sugar is mentioned as traditional sugar. Traditional sugars of India are called by different names in different linguistic regions. Khandsari and Gur are the popular forms of the traditional sugars in northern India [5,18]. Sugar is also produced from Palmyra and coconut plants through non-centrifugal method. This article does not deal with those sugar

types.

HEALTH EFFECTS OF ADDED SUGAR AND SUGAR PRODUCTS

The research works cited in this section pertain to health effects of white sugar and HFCS. WHO, in a report entitled Global status of non-communicable diseases declared NCDs as the major source of mortality worldwide [19]. The report stated that at least 40% of the deaths due to NCDs were triggered by unhealthy diets particularly overconsumption of saturated fat, salt and sugar. Shockingly, 29% of the deaths caused by NCDs in these countries occurred among people age below 60 years. In India, 53% of the deaths was attributed to NCDs. WHO warned that the deaths due to NCDs in India is estimated to touch 57% in 2020, and the same figure was 29% in 1990.

A significant number of research studies on relating consumption of sugars and prevalence of obesity and other non-communicable diseases have been conducted worldwide [20]. Though the causal relationship has strongly not been proved, most of the studies have identified positive relationship between the two phenomena. Majority of such studies have considered sucrose (white sugar) and HFCS. Review undertaken by Johnson et al. found out that many empirical studies proved intake of sugar led to harmful conditions such as accumulation of body fat and intra-abdominal fat, fatty liver, insulin resistance, hyperuricemia, metabolic syndrome, high levels of free fatty acids and diabetes [21].

A promising review undertaken by Malik et al, showed a positive relationship between consumption of Sugar Sweetened Beverages (SSB) and weight gain and obesity among children and adults. The researchers inferred that the weight gain was due to the high levels of sugar content and inadequate compensation for the total energy in succeeding food intakes after the consumption of SSB [22]. Johnson et. al., inferred in their study that likelihood of consumption of SSB causing metabolic syndrome and type 2 diabetes was high. They also related that out that high presence of rapidly absorbable carbohydrates in SSBs would have caused rise in dietary glycaemic load and hence increasing insulin resistance, inflammation and dysfunction of cells [21]. Basu et al. predicted that prevalence of overweight and obesity rate would increase to 49% and type 2 diabetes occurrences would raise to 336 per 100,000 by 2023 if the consumption of SSB continued to be at the present rate [23].

A study conducted by Misra et al. among post pubertal children in India concluded that 67% of male children with excess BMI were noticed to have insulin resistance. Overall, 22% of male children and 36% of female children had insulin resistance. Diabetes which was once common among the adults has now spread to the children. It is an alarming sign of health status of the Indian population. In the Indian context, it needs to be seriously considered that the Indian people possess high levels of hepatic steatosis, Non-Essential Fatty Acids (NEFAs), dysglycemia and insulin resistance when compared to white Caucasians. Obesity induced by overconsumption of SSBs may aggravate these metabolic dysfunctions causing serious consequences [24]. It is evident from the review of literature that greater rise in prevalence of obesity and other NCDs if consumption of SSB among the Indian population is significantly reduced.

The scientific research resumes producing body of evidence for causal association between consumption of sugar and weight gain and metabolic diseases. Despite several research studies have been undertaken on this subject the research community is still inconclusive about empirical proof and causal relationship. For example, White argues that there is no substantive evidence to prove that HFCS is responsible for obesity and he concludes the theory as a misconception. It needs to noted that HFCS is predominantly used SSBs [25]. This makes the policy makers handicapped to take appropriate interventions to curb the issue of obesity and NCD spread among the world population.

In this backdrop, the role of large scale business corporations involved in sugar refinery industry in determining findings of the research needs to the carefully analysed. Goldman in his publication entitled 'Added sugar and subtracted science' meticulously describes how the sugar refinery corporations in America and their associations influence research findings, policy decisions and consumer behaviour. These firms are driven by acute profit motive and business rivalry. He narrates that the sugar interests employ a variety of strategies to disguise science on impact of added sugar on health of human beings. The corporations have endeavoured to dishonor or curb scientific evidences generated from research if the evidences are found out to unfavorable to the corporate interests. Often, the information about such interventions is kept confidential confined to the internal records of the firm [13]. No research evidence of such incidences has been recorded in India so far. However, one cannot deny the impact of such acts in research, policy and market environments of India as majority of SSB brands operating in India are multinational companies. The knowledge community and policy making bodies need to be pro-active in expectation of occurrence of such incidences.

Policy responses to the emerging hazard

The governments and regulatory bodies, of late, have recognised magnanimity of the problems associated with added sugars and started taking policy and educative actions. WHO, has circulated a guideline to reduce the consumption of sugars among children and adults. Followed by this circular, many countries have initiated policy interventions [7]. The American Heart Association (AHA), the United States Department of Agriculture, (USDA) and United States Department of Health and Human Services (HHS) have prescribed standards for intake of sugar [26]). In United Kingdom, SCAN (Scientific Advisory Committee on Nutrition, Carbohydrates and Health) in 2015 has made new prescriptions, in which the quantity of sugar to be consumed has been reduced from 10% of the total energy to 5% [6]. Public Health England (PHE) in 2015 recommended the British people to reduce intake of sugar. The German Nutrition Society in 2016 has confirmed that there was adequate proof on health effects of sugar intake and prescribed to drink sweetened beverage rarely.

The food regulatory arm of Government of India, FSSAI released a document entitled, "Draft guidelines for making available wholesome, nutritious, safe and hygienic food to school children in India" [27]. The guidelines document recognises the ill health effects of over consumption of food containing High Fat Sugar and Salt (HFSS). FSSAI has identified school going children as central point of intervention and recommended a series of interventions to promote health dietary habit among the children. In 2018, FSSAI has circulated "notice calling for suggestions, views, comments etc. from stakeholders on draft Food Safety and Standards (Labelling and Display) Regulation, 2018" [15]. A labelling standard of declaring the per serve percentage contribution to the recommended dietary allowances in relation to quantity of energy, total fat, trans fat, total sugar and table salt has been introduced.

Another standard of depicting foods with HFSS in red colour has also been informed in the document. The policy initiatives by different countries including India reflect their good intent to promote healthy generations of the citizens. However, all of the interventions are at the nascent stage and efficacy of the policies during implementation need to be tested.

Alternative health model: food and nutrition relation to health

Popkin et al. have notably described the changes in life style and their impacts on human health as 'nutrition transition'. Five decades back, worldwide, it was considered unorthodoxy to discuss about the phenomenon of obesity. However, today the problem has become pandemic. The food habits of the people began to change after 1970's. The consumption of processed food prepared away-from-home, edible oils and sugar sweetened beverages increased significantly after this period. On the other hand, physical activity of the people reduced and inactive behaviour increased as well. Ill effects of these changes began to be realized by the populations particularly among low and middle income populations all over the world from 1990s. The issue was obviously realized by the people after large scale prevalence of diabetes, hypertension and obesity. In recent years, rapid growth in the rate of overweight and obesity are recognised among the low-income populations of the sub-Saharan Africa and Asian countries [28].

Based on the findings of Popkin et al. and the ancient wisdom of India we have attempted to provide an alternative health model. Ayurveda, one of the world's most ancient health sciences of Indian origin mentions about the connection between the gunas or behaviors and the doshas or disorders. The behavior is said to be the psychological correlates of the three disorders namely (vata, pitta and kapha). The disorders are seen as composed of five gross elements namely space, wind, fire, water and earth [29]. The doshas and gunas are said to interact with each other, and for complete characterisation of personality according to Indian psychology. Westhoff et al's. behavioral equation was used as a foundation to structure the many aspects of human experiences and behavior in which gunas are manifested [30]. Originally, the behavioral equation was developed to structure job demands that are important for assessing occupational aptitude. It provides a useful tool for systematising the factors that are important for the prediction, explanation and modification of individual behavior. Following the logic of the behavioral equation developed by Wethoff et al., we have formulated an equation for personal health given by

P=f(f,t,y)the independent variables,

P=Personal health function

f=food habits

t=tridosha (three disorders viz; vata, pitta and kapha)

y=yoga

Personal health is a function of three independent variables - food, disorders and yoga. As per science of Ayurveda, the disorders in the physical body are classified into three categories-vata, pitta and kapha. Vata disorder in the physical body may be explained as when improper vital energy (less or more) of the cell interaction with specific organ location of the body. This ordered energy can lead to anxiety, tension and fear leading to stress. Pitta is generated disordered heat energy because of metabolic activities resulting into different biological transformations in the body-mind system. It controls how we digest foods, how we metabolise our sensory perceptions and how we discriminate right and wrong. Pitta governs important digestive fire in the intestines of the body. Similarly, the kapha disorder governs the fluid lubrications in the skeletal body-mind system. The improper lubrication fluids create pain in bone joints, like knee, frontal, parietal, temporal and occipital bones of the brain in the head region [31]. Yoga is one of the world's most ancient health systems originated in India. Yoga is highly recognised in the modern medicine as a comprehensive approach to personal health. Scientific evidence proves that sustained practice of Yoga enhances physical strength and stability of mind. Yoga has been approved as a method of complementary and alternative medicine by The National Institute of Health [32].

The model has been conceived with a comprehensive perspective covering all possible independent variables that affect personal health. However, in the present article, among the three independent variables proposed we restrict only to the food habits variable since the subject under argument, sugar, is a food article. We have not attempted to empirically validate the model in this article; rather we have analyzed the research evidence available in the literature. A schematic representation of the model is as presented below

The principles of dietary types classified in the model are in line with the recommendations of WHO on healthy diet. WHO, for healthy diet, recommends increasing the share of fresh foods and limiting food articles containing high amounts of fats, sugar and salt [33]. According to Ayurveda, diet is classified into three types namely Saatvic diet, Rajasic diet and Tamasic diet [2,34]. In the present model, a characterisation of foods consumed by the contemporary population is made using this diet classification. Three broader criteria namely closeness to the nature, nutritive value and health effects are adapted to list out the characters of the foods. Characterisation of the three diet types is presented in the Table 2 given below.

It could be inferred from the characterisation of the food types given in the model that Saatvic type of diet is generally advisable for personal health, while Rajasic diet is prescribed for a specific section of people involved in occupations which require a great deal of physical energy. Tamasic diet type is considered to be unhealthy. When the diet characterisation is applied for sweeteners, it could easily be comprehended that food articles containing honey and traditional sugars such as Gur and Khandsari are Saatvic and Rajasic in nature, while diets comprising of refined form of sugars are of Tamasic quality.

It could be assumed that the people of ancient India predominantly followed Saatvic and Rajasic diets according to the personality and occupational requirements. Singh et al. through their study have attempted to test this assumption. They conducted a study on dietary habits of Kurichias, a primitive present day hunter-gatherer tribes living in Wayanad region of South India proved that their food habits were found out to be similar to the Rajasic diet advised by Ayurveda. Interestingly, it was also found out from the study that the tribes had never used sugar in their diet 50 years before the study period. However, due to exposure to mainstream world, they started using sugar [2].

Singh et al., with this evidence argue that the drastic food habit changes in the last 100 years might have caused destruction to

Table 2: Features of Saatvic, Rajasic and Tamasic diets.

Criteria	Character	Type of diet		
		Saativic	Rajasic	Tamasic
Closenesst to the nature	Nature of food	Foods which are natural, fresh and neither undercooked nor overcooked	Foods which are cooked to a high extent to enhance taste and flavour	Foods which are abundant in components that enhance taste, preserved for long period and either overcooked or undercooked
	Diet composition	Fruits, vegetables, tubers, roots, nuts, sprouted grains, milk of cow, curd, honey, raw cane sugar, sprouted grains etc.	Fruits, vegetables, honey, raw cane sugar, meats from hunted animals, butter, curd, spices, wines etc.	Fat fried foods, food articles rich in salt, sugar, spices and capsicum, meats from big tamed animals, butter and liquor
Nutritive value	Energy density	Low	Low	High
	Protein content	Low	High	Low-moderate
	Carbohydrate content	Low and slowly absorbed	Low-moderate and slowly absorbed	Moderate-high and rapidly absorbed
	Fat content	Low	Moderate	High
	Vitamins and mineral content	High	High	Low
Health effect	Effect on physical status	Offers body lightness alertness and energy	Stimulates and pushes the organs to increase speed and indulge more physical activity	Creates heaviness and sluggishness
	Effect on psychological status	Enhances happiness, calmness, consciousness and spirituality	Causes excitement, confidence and increased intelligence	Enhances anger and criminal tendency and impedes spiritual thoughts
	Effect on health	Enhances longevity and health	Good for physical, mental and social health	Bad for health
	Suitable for	People with cool nature and peaceful temperament	People who work primarily using physical energy e.g. warriors, sportspersons, hunters etc.	Not advisable to anyone
Adapted from the sources: [2,34]				

the genes of human beings, triggering upsurge of NCDs in recent years [2]. Eaton et al stated that the genetic composition of present-day humans shows a minor difference from that of the humans who lived in Africa region 50-100,000 years ago. The cotemporary humans' genes appear to be similar to that of our forefathers lived in Paleolithic period. In the last 10,000 years, there has been a very little change in our genes, possibly 0.005% since there was no considerable change in the nutritional environment in which human beings lived. However, in the recent 100-160 years, there has been a significant change in the dietary habits. There is an increased consumption of refined carbohydrates associates with declined consumption of complex carbohydrates, mineral, essential amino acids, vitamins and antioxidants. The changes in association with inactive behaviour, mental stress, pollution, consumption of liquor etc. in the last 100 years, may have led to damage to the genes ultimately causing spread of NCDs [35].

Research evidences show that the dietary behaviour of contemporary human beings can easily related to Tamasic diet. Maxwell and Slater observed that per capita consumption of millets in China declined sharply after 1990s while there was a marked increase in the consumption of animal products. The proportion of energy derived from fat increased nearly by 50% [36]. Shetty observed similar nutritional transition on India causing large scale spread of obesity and chronic diseases [1]. Among the Indian population, there has been a considerable reduction in consumption of traditional sugars in the latest four decades while the consumption of refined sugars has sharply increased during the same period [37]. The model proposes that promotion of Saatvic diet type among the populations will enhance the personal health. In the following section, research evidence from the literature in analysed the characteristics of the traditional sugars using the three criteria given in the model.

NUTRITION TRANSITION AND TRADITIONAL SUGARS

Sugars have been occupying the diet of human beings right from the beginning of mankind [25]. The invention of the most accepted sweetener worldwide, sugar, happened in India. Atharva Veda, an ancient Indian religious manuscript refers sugarcane cultivation and sugar preparation. The word sugar derived from the Sanskrit term sarkara meaning gravel. Fruits and nuts which consist large quantity of glucose, sucrose and fructose had been the primary source sugar, supplemented by occasional access to wild honey when the human beings were hunter-gatherers in forests. Even though sugarcane, the major source of sugar, was domesticated over 10,000 years before, the sugar became widely available worldwide only before few centuries [25]. Sugarcane was first domesticated in 8000 BC in New Guinea and progressively reached regions

like south east Asia, China and India. The early manuscripts of China in 800 BC comprise of reference to sugar and sugarcane farm fields of India. In 500 BC, the process of producing juice of sugarcane was developed in India. Alexander the Great, in 300 BC brought the 'the sacred reed' for the first time to Europe. Greece and Roman started to import sugar juice as a rare sweetener and drug. In 400 AD, Indians invented the method of manufacturing granulated sugar crystals from the sugar juice. By 600, sugar became an important trade item in world. In 600-1200 AD sugarcane was introduced to Asian, African and European countries. During 700-1200 AD Muslim countries in Middle East and Asia adopted sugar production methods of India. In 1400-1700 sugarcane was introduced by the Dutch sailors to Caribbean islands. In 1700, sucrose was extracted from beetroot in Europe. Frist beet sugar factory was established in Europe [25]. From 1930s, sugar refineries were introduced in India.

Sugar, from the status of rare and medicinal item, became a food necessity between 1800 and 1850. Sugar was commonly used in drinks, deserts, confectionary products and preserves. The technology of centrifugation to isolate sugar from sugarcane molasses was invented. The High Fructose Corn Syrup (HFCS), a liquid sweetener, was extracted from corn plant and gradually the new product occupied nearly 50% of the sugar market in America. However, sugar (produced from sugarcane) remains to be a predominant sweetening agent worldwide. As of 2018, India is the second largest producer (33.83 million metric tons) in the world next to Brazil. India ranks first consumption of sugar in the world with 27.50 million metric tons [38,39]. India is the largest manufacturer of Khandsariand Gur, traditional sugar products manufactured using non-centrifugal methods [40].

Rao et al. mentions a decline in share of traditional sugar production in India. Nearly two thirds of the total sugarcane produced had been used for manufacturing of the traditional sugars 1930's. However, after introduction of sugar refinery mills and their significant growth and increased demand for white sugar associated with increase in per-capital income among the population, the demand for the traditional sugars declined. By 2000, only 32.5% of the total sugarcane produced was used for manufacturing of Gur and Khandsari. Rao et al. also calculated the trend in per capital consumption of the traditional sugars in comparison with white sugar. The overall consumption of sugar (including traditional sugars and white sugar) increased from 19.80 kg per annum (in 1975-76) to 26.47 kg per annum (in 2000-01). It was also found out that the per capita consumption of the traditional sugars decreased from 13.74 kg per annum to 8.72 kg per annum between 1975-16 and 2000-01. On the other hand, the per capita consumption of white sugar increased from 6.06 kg per annum to 17.75 kg during the same period [37]. The latest data on production and consumption of the traditional sugars are not available.

TRADITIONAL SUGARS DISTINGUISHED FROM REFINED SUGARS

Though both traditional sugar products like Khandsari, Gur etc. and white sugar are produced from the same raw material, the two groups are distinct in features such as time tested nature, production processes, nutritional composition, structure and medicinal properties. The special features of the traditional sugars are described in this section. Using the conceptual framework given in the alternative model of this article, we have analysed the characters of traditional sugars in comparison with the refined sugar products. The criteria used for the analysis are closeness to the nature, nutritional values and health effects (Table 3). Summarises key findings from the recent research literature on nutritional and medicinal values of the traditional sugars.

Table 3: Nutritional and medicinal values of the traditional sugars as found in the recent literature.

Property	Reference	Key findings
Nutritional values	Rao et al. [37] Singh et al. [41]	Traditional sugars are complex substances; sucrose is bound with micro and macro nutrients
Nutritional values	USDA [42] USDA [43]	In refined white sugar and HFCS, greater than 99% of the sugar is constituted by pure disaccharides
Health effects	Karthikeyan and Samipillai [44]	Gur is used as a laxative, diuretic and aphrodisiac drug
Health effects	Shrivastav et al. [45]	Traditional sugars are rich in iron and they are administered to treat anaemia
Health effects	Jaffé [5]	Intake of beverage of a traditional sugar increased haemoglobin content
Health effects	Takara et al. [46]	Two phenolic compounds extracted from sugarcane molasses showed inhibitory characteristics against cariogenic bacteria
Health effects	Singh et al. [47]	Raw cane sugar reduced genotoxic effects of arsenic in the cells of bone marrow in mice
Health effects	Asikin [48]	Identified a trace of policosanols, which are attributed to lowering of blood lipid

Closeness to the nature

While the traditional sugars make use of naturally available materials for the purpose of purification, the modern refinery processes use chemicals. Production process of the traditional sugars is unique. They are produced by evaporating the water content in the sugar juice. Natural clarificants such as mucilage of Hibiscus Ficulneus, Hibiscus esculentus, Bombax malabaricum, Grewia asiatica, Kydia calycina, Ricinus communis etc. are generally used during manufacturing of the traditional sugar [12]. Molasses is retained in the final product of traditional sugars whereas it is separated through refinery process in case of white sugar. In case of refinery process, chemicals such as lime, calcium carbonate, calcium sulphate etc. are used [41].

Nutritive values

Traditional sugars are rich source of nutritionally and functionally important macro nutrients, minerals and vitamins. Rao et al., describes naturally present sugars as complex substances, in which disaccharides are usually bound with other macro nutrients, minerals and vitamins [42]. During digestion, they are broken down slowly and offer a stable release of energy. The nutritional composition per 100 g of Gur is presented in Table 4 [41].

Table 4: Nutritional composition of 100 g of Gur.

Carbohydrates (g)		Vitamins (mg)	
Sucrose	72-78	Provitamin	2.D
Fructose	1.5-7	Vitamin A	3.8
Glucose	1.5-7	Vitamin B1	0.01
Minerals (mg)		Vitamin B2	0.06
Calcium	40-100	Vitamin B5	0.01
Magnesium	70-90	Vitamin B6	0.01
Phosphorus	20-90	Vitamin C	7
Sodium	19-30	Vitamin D2	6.5
Iron	10-13	Vitamin E	111.3
Manganese	0.2-0.5	Vitamin PP	7
Zinc	0.2-0.4	Protein	280 mg
Chloride	5.3-0	Water	1.5-7 g
Copper	0.1-0.9	Calories	312

While the traditional sugars are made of sucrose, minerals and vitamins, the white sugar is purely of disaccharides. 100 g of granulated white sugar contains 99.80% of sucrose [42]. The same quantity of HFCS comprises of 75.65% of disaccharides and 24% of water [43]. This means that the dry matter of HFCS comprises 99.54% of disaccharides. Minerals and vitamins are removed from the composition during the refinery process of white sugar and HFCS. The traditional sugars do not contain Sulphur, a chemical harmful to health beyond critical levels. On the other hand, white sugar and HFCS, due to the refinery process that they undergo, comprise Sulphur. The traditional sugars, in terms of structure, are complex when compared to white sugar and HFCS. The traditional sugars release energy slowly and for a longer time while the refined sugar releases energy immediately. The food articles which release energy at slow pace have been proven to be harmless to human health. Refined sugar, which is constituted only by sucrose, on the other hand, easily gets assimilated and gives a quick source of energy, leading to rapid increase in blood glucose upon intake [44].

Health effects

The ancient health systems namely Ayurveda and Unani consider sugar as a valuable medicine. According to the traditional healers of Chattisgarh use Gur is sugary, oleaginous, diuretic aphrodisiac and beneficial in weakness, thirst, leprosy, intestinal problems, anaemia, erysipelas, swelling, ulcer etc. In Unani medicine, Gur is used as a laxative, diuretic and aphrodisiac drug. Sugar juice is beneficial to patients of liver related diseases [45]. The traditional sugars are rich in iron and hence can be administered as food supplement to the anaemic patients [37]. Shrivastav et al, mention that district administrations of India distribute Gur to the victims of natural calamities for health benefits. In a 12-week randomised, controlled double blind clinical trial among pre-school children in Brazil a statistically significant increase in haemoglobin with the consumption of beverage of the traditional sugars was observed [5]. Takara et al., isolated two phenolic bioactive compounds from the molasses of sugarcane and they found out these compounds showed inhibitory characteristics against the cariogenic bacteria Streptococcus mutants and Streptococcus sobrinus when compared with anti-bacterial agents [46]. Singh et al., confirmed that mice fed with the raw cane sugar stopped reduction of total antioxidants, glutathione peroxidase and glutathione reductase and rise of interleukin-1b, interleukin-6 and TNF-a in serum, reduced the genotoxic effects of arsenic in the cells of bone marrow and antagonized the lesions related to emphysema and thickening of alveolar septa [47]. Kadam et al. reported a defensive role of sugarcane juice against the DNA damage induced by radiation, using E. coli and pBR322 plasmids in vivo models [48]. Asikin et al., identified a small trace of policosanols, specifically octosanol, which have been accredited with lowering of blood lipid [48].

Jaffé has made a seminal review of scientific literature on health effects of these sugars. He reviewed 46 research works on health effects of the traditional sugars and he concluded that there was a substantial evidence to confirm positive health effects of the traditional sugars among the human beings. He reported that the traditional sugars possess features such as immunological effects, anti-toxicity and cytoprotective effects, anti-carcinogenic effects, diabetic effects and hypertension effects. He also raised concerns over non-recognition of the nutraceuticals properties of the traditional sugar products [5, 18]. Jaffé pointed out that, worldwide, the traditional sugars were included in the database of antioxidant properties and phenolic compounds in foods, created in the recent years. Such as the USDA database on radical absorbance capacity, flavonoids and proanthocyanidins and French national institute for agronomic research database on phenolic compounds. He also mentioned that no scientific reviews on antioxidants and phenolic compounds have considered the traditional sugarcane products [18]. Table 5 describes the differences between the two groups of sugars in detail.

Table 5: Comparison of properties of traditional sugars and refined sugars.

S.No	Property	Traditional sugars	Refined sugars
1	Composition	Made of sucrose, fructose, protein, minerals and vitamins	Made of monosaccharide's and disaccharides
2	Nutritional benefits	Highly nutritious; for example, used as a nutritional supplement to cure anaemia	They are of empty calories i.e. they do not provide any nutritional benefits and hence there is no safe level of intake
3	Rate of energy release	Made up of complex carbohydrates and hence they release energy slower than simple sugars	Made up of simple sugar components and release immediately release energy
4	Medicinal values	Have immunological effects, anti-toxicity and cytoprotective effects, anti-carcinogenic effects, diabetic effects and hypertension effects	No medicinal values
Source: [37,45,17]			

Analyses in this section easily infer that the traditional sugars possess properties of Saatvic type of foods due to the processing methods involving natural materials, richness in nutritional values and abundant medicinal values. On the other hand, refined sugars due to their high energy density, rapid absorption capacity in the body, lack of vitamins and minerals, processing methods involving chemical clarificants and negative health effects could be related to Tamasic diet type. These differences need to be considered while defining classifying sugar products in food and drug standards.

Policy analysis and recommendations

The international community has recognised the problem of overconsumption of sugars as it leads to serious life cycle disorders among human beings. Many countries including India have initiated policy and behavioral change measures to curb the magnitude of the problem. The interventions are at the initial stage and may require longer time to produce results. On the other hand, it needs to be noted that the policy interventions are centered around reducing consumption of refined sugar and they have not considered alternatives available in the indigenous wisdom. Traditional sugars, given their potential nutritional and medicinal properties, could play a significant role in addressing the menace of sugars. The policies have also ignored the element of conventional diet practices followed by the native communities. With this backdrop, the researchers have developed recommendations for policy use. The policy recommendations are as follows

There is dearth of research undertaken for deeply understanding nutritional and medicinal properties of traditional sugars all over the world. India being the largest producer of the traditional sugars needs to spearhead the research activities. Research will be able to give empirical evidence for the time tested nutritive and medicinal values of the traditional sugars. Ministry of AYUSH with the support of research institutions in the country need to initiate the research works.

The traditional sugars being distinct from refined sugars in terms of nutraceutical values, a separate body for regulating Khandsari, Gur and other similar products could be promoted under the domain of Ministry of AYUSH.

Efforts need to be taken up to list the name of the traditional sugars in databases of scientific agencies like USDA, French National Institute of Agronomic Research to record nutraceuticals properties of these sugars.

The draft food labelling and display standards circulated by FSSAI have classified all types of sugars into one group. It has defined sugar as all monosaccharides (glucose, fructose etc.) and disaccharides (maltose, sucrose, lactose etc.). This means that the traditional sugars which have high nutraceuticals properties are treated same as refined sugars which are of empty calories and no medicinal values. FSSAI needs to place both types of sugars in different classes and it should reflect in the labelling of the packaged food articles to make aware the consumers.

Media advertisements play a key role in decisions made by the consumers on purchase of food articles. Since the SSBs and other foods with HFSS have been proven to deteriorate health of the children and adults, significant restriction on the advertisements of such food products need to be imposed by the Government of India.

Traditional dietary practices need to be promoted among the people. Regulatory and educative actions for promoting traditional foods need to be undertaken by the Government of India. Educative measures described in the draft guidelines of FSSAI need to be piloted as an action research in sufficient number of places across India and the research findings need to be made available for wider dissemination.

CONCLUSION

The researchers described an alternative model on alternative and supplementary health model and attempted to validate the food habits component of the model through analysing the evidence from the literature. The model has not been empirically validated in the present article. The researchers propose to undertake further research on the subject to test the validity of the model. A review of literature on the prevalence of obesity and NCDs in India and other world countries and its association with overconsumption of SSBs and other food articles with added sugar was undertaken. It was comprehended that magnitude of the problem is alarming requiring immediate action. Governments across the world including India have recently declared policy interventions against the hazard. The qualitative analysis also revealed that the ancient Indian communities followed systematic dietary principles prescribed by the indigenous wisdom and lived healthy throughout the life. Deviating from the native culture in the latest century has caused severe destruction of health status of the people. The governments, civil societies and local communities need to work together to restore the forgotten native wisdom in relation to diet and life style. As a first and significant step towards such endeavours, the traditional sugars, which have been in existence for many centuries in the country, whose nutritive and medicinal values are time tested need to be given due recognition in scientific databases, policy documents and research works. Our causal findings strongly support the notion that future research and policies need to be inclusive and more sensitive to local Indian tradition and wisdom on Khandsari and Gur impacts on food safety and standards on nutritional aspects. This policy recommendation will be a key to achieve health security and wellness lifestyles while ensuring Indian traditional sugars production of safe and locally affordable foods.

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