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Review Article

Jaggery as a Potential Source of Nutraceutical in Food Products

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ABSTRACT

Nutraceutical, functional, or fortified food balances the diet and aids in the development of immunity and prevents illness. Consequently, it delivers medical benefits in along with the nourishment. Foods that are healthy, safe, and simple to prepare are in high demand especially those which provide additional health benefits. One of them is jaggery (non-centrifugal sugar), which is manufactured from sugarcane juice. It has been known to mankind for about 3000 years and is an important part of many countries' rural diets. Because of the presence of amino acids, antioxidants, phenolics, and minerals, jaggery is considered as a nutraceutical. Jaggery is one of the world's most wholesome and beneficial sugars. It provides natural supplies of minerals and vitamins found in sugarcane juice and contain micronutrients having anti-carcinogenic and antitoxic characteristics. Jaggery is a better natural source of nutrients and could be utilized as a healthier nutritional option for white sugar. The nutraceutical value of jaggery can be increased by fortifying it with medicinally significant herbs and spices. This paper gives an overview of jaggery in terms of its processing and value addition aspects for its improved quality and safety.

Keywords: *Jaggery, Nutraceutical, Sugar, Sugarcane.*

INTRODUCTION

The sugar industry is the second largest agro-based industry in India and contributes significantly to the socio-economic development of the rural population. It supports 50 million farmers and their families and provides direct employment to over 0.5 million skilled and semi-skilled persons. India currently produces 27.7 million metric tons of sugar and 6.6 million metric tons of jaggery, respectively (Quadri, Madhavi, Navya, Jayaprakash, & Rajender, 2022). Jaggery making is one of the common agricultural activities in sugarcane growing areas. Jaggery is a natural sweetener made from sugarcane juice simply by evaporation. Cane jaggery, according to Food Safety and Standards Authority of India (FSSAI), is a byproduct of boiling or processing sugarcane juice (*Saccharum officinarum*). Jaggery is often stated to as "medicinal sugar" due to its use in Ayurveda and its comparison to honey. It contains an enormous wealth of minerals, protein, and vitamins.

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It can be regarded as one of the healthiest sugars in world because of its nutritional qualities. Jaggery contains substantial amounts of magnesium, potassium, sodium, and iron, all of which have major health benefits. Jaggery is consumed either directly or used to prepare a variety of sweet-based meals in Indian cuisine (Quadri et al., 2022).

Jaggery is a key component of the Indian diet and is used to make a variety of meals with a sweet flavor. Sugarcane farmers manufacture jaggery with minimal capital expenditure and to create low-calorie and sugar-free muffins, several researchers have attempted to replace sugar. The majority of traditional sweet foods are prepared using jaggery (Inamdar, Chimmad, & Naik, 2005). Jaggery has been used by to create peanut and chickpea nut Chikki (Tidke, Sharma, & Kumar, 2017). According to (Nath, Dutta, Kumar, & Singh, 2015), the value addition of jaggery-based products from the jaggery industry is the nation's largest unorganized sector. Jaggery may have diverse natural flavors (ginger, black pepper, cardamom, lemon, etc.) added for flavor, texture, nutrition (protein, vitamins, and phytochemicals), and taste (additives like nuts, spices, cereal, and pulses). In addition, a variety of value-added products, such as rosagolla, peda, curd, and laddu (puffed cereal, nuts, and sesame, etc.), are historically produced using jaggery rather than sugar, although there are no scientific works of literature or process methods available for commercial use. Other applications include making jaggery toffees and cakes with spices, cashews, pecans, and pumpkin preserves. Alcoholic beverages like palm wine can also be made with jaggery. Jaggery can thus be a great potential nutraceutical and the improvement in the context of value addition and processing is of excessive importance for its overall quality and safety.

Value addition of Jaggery

Value addition of jaggery refers to improvement in the overall composition of the final product. Various studies have been done for the enhancement in the jaggery products. In one of the study method standardization for production of jaggery was done with the addition of whey. It was observed that whey could be used to create good-grade nutritional Jaggery (Madariya & Rao, 2012)**.** The most popular items that are consumed by many people, particularly youngsters, and used as a source of energy in addition to their high nutritional content are chocolate-based products. In other study chocolate nuggets were developed using jaggery powder, which include an abundance of vitamins, minerals, protein, and beneficial sugar compared to sugar. The recipe for chocolate nuggets utilizes nuts, spices, cocoa butter, cocoa powder, and jaggery powder. An optimized process was developed for the formation of Jaggery based chocolate nuggets (Omre, 2013). In one more study, a suitable sugarcane variety was used to make value-added jaggery and simple jaggery in bar form. Jaggery is a natural sweetener full of nutrition. To make it further nutritive, process for production of value-added jaggery using Aonla has been developed at Indian Institute of Sugarcane Research, Lucknow. Jaggery contains a substantial amount of vitamin C besides good taste and palatability. The percent recovery of fine granules (1000-2000μ) in jaggery syrup significantly decreased with increase in seeding level. Recovery of medium and coarse size granules increased with increase in seeding levels indicating the effect of nucleation. Nucleation during cooling stage enhances the process of granulation. All sizes granules were seen attractive in terms of color, appearance and texture.(P. K. Kumar & Dubey, 2012).

Several studies on value addition in jaggery have been conducted. Jaggery was fortified with *Elettaria cardamomum* at 0.05%, 0.1%, and 0.2% of Co 86032, Co 419, and Co 62175 sugarcane varietals. The in vitro antioxidant capacity, namely 1,1-diphenyl-2-picrylhydrazyl (DPPH) was assessed for its extreme power of reduction and scavenging skills. Amplified antioxidant activity in fortified jaggery demonstrated by its capacity to reduce and scavenge DPPH radicals

(Chandrakanth, Mysore Annaiah, Shivalingaiah, & Chikkappaiah, 2019). In another research impact of jaggery on the pasting properties of wheat flour and physicochemical properties of Muffins were investigated. Different egg amounts of 42, 63, and 84% were used to make different types of muffins. Pasting temperature and peak viscosity were both raised. Both muffins were found to be microbiologically safe (Lamdande, Khabeer, Kulathooran, & Dasappa, 2018). In another study, activated carbon from bagasse was used to purify raw cane juice to enhance quality of jaggery (panela), a nutritious sweetener that is popular around the world due to its nutritional benefits. Ultrafiltration was applied to purify cane juice for comparison and potential complementary purification methods. Both treated and untreated juices were analyzed for physicochemical properties. Jaggery was developed using the purified samples. Microbial counts in this jaggery were within the prescribed limits even after three months at room temperature (Solís-Fuentes et al., 2019).

Fruits and vegetables are micronutrient-packed foods that help control many degenerative diseases and increase the quality of life. Bars were created by combining pineapple, beetroot, and dates with various jaggery combinations (Sree et al., 2020). When making jaggery, an effort was made to create ready-to-use clarificants powder. Okra stem, soybean seed, and fenugreek seeds were chosen for the creation of a mixture of bio-clarificants. (R. Kumar et al., 2021).Functional jam (strawberry & kiwifruit) was developed that had a higher fruit-to-sugar ratio than traditional ones with the incorporation of jaggery. Granulated jaggery can be used to produce sugar-rich food products including jams (Cervera-Chiner, Barrera, Betoret, & Seguí, 2021). Jaggery was used in place of traditional osmotic agent to create nutritious coconut chips, which offset the negative effects of refined sugar on health (Pravitha, Manikantan, Ajesh Kumar, Beegum, & Pandiselvam, 2021). Study have shown that jaggery might be utilized to make probiotic set yogurt with better physicochemical, microbiological, and sensory properties (Tripathi & Agarwal, 2022).

New product development with Jaggery

Product development refers to the activities involved in taking a product from concept to market. There are numerous processes involved in moving a product from the early stages of product development, such as product concept generation and market research, to research and development, manufacturing, and distribution. Traditional non-centrifugal cane sugar known as jaggery is popular in Southeast Asia and the Indian Subcontinent. It is a concentrated product made from cane juice and commonly date or palm sap, with little separation of molasses and crystals, and its color ranges from golden brown to dark brown. Several studies were conducted in the creation of jaggery products, one of which is Bomboyson made from 100 parts khoa, 40 parts sugar, and 20 parts ghee was discovered to be superior to a control product (Gartaula & Bhattarai, 2014). Sugarcane juice is concentrated to create jaggery, a natural sweetener. Sap from various palm trees, including the sago palm (*Caryota urens L*) and wild date palm (*Phoenix sylvestris Roxbius Roxb*) is used. Jaggery's micronutrients have qualities that make them non-toxic and anti-carcinogenic (Nath et al., 2015). A new jaggery based product including Oleoresin, a combination of ginger and lemongrass, was used to create jaggery cubes (Journal, 2020). Many traditional meals and ayurvedic drug formulations contain liquid jaggery. It is a good nutraceutical because it has additional nutritious components that provide a variety of medical benefits. Turbid liquid jaggery products were produced by adding citric acid.(Irudayaraj, Palaniswami, & Vennila, 2021)

Several jaggery based products are developed like in one of the study Organic jaggery cookies were developed having considerably more iron (2.20 mg/100g) than conventional cookies (p 5%). Potassium content (220.0 mg/50g) and calcium content (180.10 mg/40g) were both higher in Jaggery cookies than in conventional cookies (R. Kumar et al., 2021). As per the studies, development of a jaggery powder enhanced with vitamin C by adding through cut pieces of amla fruits, dried up to 10% moisture content, was deemed to be the best (Anwar, 2017). Researchers have evaluated the effect of substituting jaggery for sugar in the product formulation of Bomboyson, a traditional dairy product and they found that this did not affect the product's overall acceptability while increasing its mineral content. At 5°C and 25°C, the product can be safely stored for up to 28 days and 21 days, respectively (Gartaula & Bhattarai, 2014). Jaggery powder with a particle size of less than 2 mm was made by sifting and placed in polythene bags. Jaggery granules were used to make jaggery chocolates, which are healthier than those made with sugar. The formed samples had good flavor and textural qualities and contained 50% granular jaggery (Quadri et al., 2022). Basundi is a traditional Indian dish made from buffalo milk with 6% fat and jaggery added at various stages in the manufacturing process (Tripathi & Agarwal, 2022).

Upgradation in the jaggery Manufacturing process

As the demand for this nutritive sweetener grows, attempts are being undertaken to produce a uniform manufacturing package that would boost productivity while also improving quality in terms of sanitation, standardization of shape, size, and storability. Several studies are being conducted in this regard. Jaggery is traditionally prepared in open earth pan furnaces, however, these have very poor thermal performance. The heat needed to bring sugarcane juice to the boiling point can be provided by solar collectors. The performance of the jaggery production unit can be improved by utilizing solar collectors and solar driers.(R. Kumar et al., 2021)**.** Edible coating could be one of the best alternatives for protecting jaggery cubes from water loss. Different ratios of CMC and HPMC concentration in glycerol solution were applied to jaggeries cubes. As concentration increased, the edible-coated jaggery's moisture content decreased, while TVC decreased with an increase in the ratio of CMC and HPMC**.** (A. Kumar, Chand, Shahi, Kumar, & AK, 2017). A study was done to understanding of resource transformations and consumptions in the jaggery process. The baseline process, for which the exergy efficiency and exergy destruction are computed, was operationally adjusted. Excess energy was lost as heat in the form of flue gas, which was decreased by 11.5% as a result of process changes. Flue gas emissions into the environment were the most obvious source of resource waste, but energy destruction resulting from irreversibility's in combustion accounted for most of the human resource consumption. (Khattak, Greenough, Sardeshpande, & Brown, 2018).

Making jaggery is a traditional practice in which knowledge about the use of various chemicals in the process is passed down from generation to generation. One of the chemicals commonly used in this process is phosphoric acid. The addition of acid causes sucrose inversion, which is undesirable for high-quality jaggery beyond a certain point. However, when used correctly it improves the color and texture of jaggery and aids formation of smaller-sized crystals (Verma, Shah, & Mahajani, 2019). A low carbon three pan jaggery making furnace was developed with food grade steel content. The treatment with 120°C striking temperature and 50% juice depth was found to be the best of all treatments. The effect of two independent variables, striking temperature 118 °C & 120 °C and depth of juice 25%, 50%, and 75% on quality parameters such as total sugars and color transmittance was studied.(TH, VK, PJ, & MR, 2021). A modified plant with two pans is developed to boost its ability to transfer heat. This exhibits higher rates of heat utilization (31.23%), water evaporation (32.92%), jaggery production (44.83%) and thermal efficiency (35.32%) while lower rates of bagasse consumption (4.41%) (R. Kumar & Kumar, 2021). Unrefined sweetener known as jaggery is made by heating fresh sugarcane juice in a variety of ancient indigenous and modernized plants. Researchers have proposed several changes for the improvement and optimization of performance characteristics of these plants and processes. Fins at outside of pans, a preheater and economizer in chimney, an efficiency booster in the furnace, and forced airflow through the plant are said to increase thermal efficiency by 25% to 50% and decrease bagasse consumption by 1.75 kg/kg to 2.75 kilograms (R. Kumar & Kumar, 2022).

CONCLUSION

Indian Jaggery industry is the largest unorganized sector in the country. The majority of the sugarcane growers are manufacturing jaggery with minimum capital investment. Jaggery is nutritionally beneficial and contains useful nutritive and nutraceutical elements needed for a healthy human life. Jaggery products' nutritional and functional value is increased, boosting dietary and health benefits. The addition of many herbal components to jaggery increases its therapeutic efficacy and makes it suitable for regular usage. It should be publicized and popularized in society for better healthier and happier living. Various studies have proved an increased value addition and fortified jaggery products have not only led to the increased consumption of jaggery but its benefits in the form of nutraceutical as well. Also improved processing parameters has led to the improved quality and safety of the jaggery products.

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