IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Beetroot And Ginger: A Comprehensive Review Of Health Benefits

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Abstract

Beetroot (*Beta vulgaris*) and ginger (*Zingiber officinale Roscoe*) are both root vegetables that have been known to possess a variety of essential nutritional components and pharmacological properties that may aid in the prevention and treatment of a variety of diseases and conditions. Several studies have shown that betalains from beetroot have strong antiradical and antioxidant effects, are low in calories, fat-free, and abundant in fiber and minerals. The green leafy part of the beetroot is also nutritionally advantageous, as it contains beta-carotene and other carotenoids. Ginger, on the other hand, has a high concentration of phenolic compounds, terpenes, polysaccharides, lipids, organic acids, and raw fibers. Ginger's phenolic components, which include gingerols and shogaols, are primarily responsible for its good health benefits. Therefore, incorporating both roots into food products can provide individuals with a number of health benefits. In this review, we talked about the nutritional content, medical benefits, and value-added food items of beetroot and ginger.

Keywords: Beetroot, ginger, nutrition, medicinal, food applications

Introduction

With the introduction of new innovations, the market for food goods is continuously expanding. The increasingly rapid growth of the times in this era of globalization is changing society's perceptions of food products. Previously snacks were chosen based on their ability to fill and satisfy the stomach. However, humans are increasingly realizing the value of nutritious, low-calorie diets. As a result, producers innovate by utilizing ingredients that can boost the nutritional content of the food product (Muhamad., 2019) immunity of the individuals.

These days, fresh fruits and vegetables, as well as their products, are in high demand due to their abundance of biologically accessible phytonutrients and other health-promoting components. The natural components contain anti-carcinogenic and other beneficial qualities, hence they are known as chemo-preventives. They have been identified as important sources of a diverse range of phytochemicals that may enhance health separately or in combination. As a result, fruits and vegetables have been designated as "functional foods" (Kaur et al.,2022).

Vitamins, vital minerals, antioxidants, and prebiotics (fibres) are among the components found in vegetables and fruits that have been linked to various health benefits and the majority of which have been tested in intervention studies. Raising consumer awareness regarding functional foods necessitates the discovery of new bioactive substances that may be used in the development of functional products. As a result, researchers have focused on natural substances such as polyphenols, carotenoids, peptides, sterols, and polyunsaturated fatty acids (PUFAs) and their bioactivities. Functional foods contain a wide range of food components, including vitamins, herbs, mineral supplements, probiotics and phytochemicals, all of which are associated with disease prevention and promotion.

Food waste management is an ongoing environmental issue. Increased production and growth of fruits and vegetables, and the shortage of suitable handling procedures and infrastructure, has resulted in massive losses and wastage of these vital food commodities, as well as their components, byproducts, and residues. Excessive losses and waste in the fresh and processing sectors are becoming a major nutritional, economic, and environmental issue. Fruit and vegetable processing generates large byproduct waste, accounting for 25% to 30% of the total commodity group. The waste is primarily made up of seed, skin, rind, and pomace, all of which include potentially useful bioactive substances like carotenoids, polyphenols, dietary fibers, vitamins, enzymes, and oils, among others. These phytochemicals derived from agro-industrial food waste can be employed as functional food additives and natural antioxidants to replace their synthetic counterparts, which are increasingly being rejected. According to the United Nations Food and Agriculture Organization (FAO), at least one-third of all food produced worldwide (estimated at 1.3 billion metric tons) is wasted or lost each year (FAO 2014), with horticultural commodities experiencing the highest losses and waste of any type of food, reaching up to 60% (Gustavsson et al.,2011). The use of waste for the manufacture of several vital bioactive components is an essential step towards sustainable development.

Beetroot is considered as one of the most potent veggies due to its high antioxidant content. However, because these goods are seasonal and perishable due to their short shelf life, they must be processed in order to maintain quality traits (Scibisz and Mitek, 2009). Preserving

fruits and vegetables can help extend their shelf life by reducing moisture content (Šaponjac et al., 2016).

Beetroot: A potential functional food

Beetroot (*Beta vulgaris L.*) is part of the Amaranthaceae or Chenopodiaceae family of flowering plants. Some categorization systems classify beetroot as belonging to the Chenopodiaceae subfamily and the Amaranthaceae family. It has multiple varieties ranging in color from yellow to red, with the deep red beets being the most grown and commonly utilized (Ibraheem et al. 2016). Beetroot is a plant's taproot. Betacyanin and betaxanthin (betalains) are heterocyclic and water-soluble nitrogen pigments that give beetroot tubers their red-purple color while also acting as antioxidants (Ravichandran et al., 2013; Volp et al., 2009).

Beetroot is also known as beet, spinach beet, sea beet, chard, garden beet, white beet, and Chukander (Hindi). It contains various therapeutic attributes that have a beneficial impact on the human body. Beets can be eaten raw, cooked, steamed, or roasted. They are easy to grow and are consistently placed among the top 10 vegetables grown in India (Chauhan et al., 2020).

Beetroot has been grown for food purposes (pickles, salads, and juice), rather than for sugar manufacturing. In contrast to other fruits, the primary sugar in beetroot is sucrose, with trace amounts of glucose and fructose (Bavec et al., 2010). Because fructose reduces exercise capacity, sports drinks may contain low fructose and high sucrose content. Beetroot powder is commonly used as a coloring ingredient in food products.

Beetroots or processing and the fresh market are primarily picked in September and October. Yields of 20,000 kg per hectare (Beetroot, 1983). The beetroot market is small, but it is considerable, as it deliveries to wholesalers. In long-term, the sales period might be prolonged to the roots (Boswell, 1967).

Nutritional and bioactive composition of Beetroot

Beetroot is a rich source of higher nutrients such as carbs, sucrose, proteins, minerals, vitamins (ascorbic acid, B-complex, and vitamin C), fiber, minerals, antioxidants, betalains, and phenolic compounds (Lundberg et al., 2008; van Velzen et al., 2008; Aykroyd 1963).

Beetroot's antioxidant properties are mostly attributed to the presence of phytochemicals such as phenolic acids, catechins, and flavonoids. These phytochemicals have been reported to protect against hypertension, hyperglycemia, inflammation, and liver damage (Vali et al., 2007; Ninfali and Angelino 2013; Singh et al., 2011; Jain et al., 2011). Among the several vegetables examined, beetroot was found to have high antioxidant activity (Kapadia et al., 2011). Rutin, caffeic acid, and epicatechin are the most abundant bioactive phenolics in beets, providing good oxidative protection (Georgiev et al.,2010; Tesoriere et al.,2004). Beetroot contains a significant amount of betalains, which are harmless, nitrogenous colors that are water soluble. They occur naturally in beets as betaxanthins (yellow) and betacyanins (red), and are widely utilized as food additives (Reddy et al., 2005; Oksuz et al., 2015). Beetroot also contains important compounds such as glycine, betaine (De Zwart et al.,2003), saponins (Atamanova et al., 2005), betacyanin (Patkai et al.,1997), carotenoids (Dias et al.,2009), folates, betanins, flavonoids and polyphenols. Beetroot contains the nitrogen pigment betalain, which acts as an antioxidant.

Figure 1: Nutritional profile of beetroot (Bangar et al.,2022)

Beetroot is a beneficial food for health. Beetroot enhances consumer health and well-being because it contains the nitrogen pigment betalain, which acts as an antioxidant. Beetroot's health advantages stem from its high content of important minerals and vitamins. Beetroot's antioxidant phytochemicals are crucial for maintaining good health.

Beetroot offers a variety of therapeutic characteristics that can help protect against heart disease and various cancers (including colon cancer) (Kavalcova et al., 2015). They are also known for their antibacterial and antiviral properties (Strack et al., 2003), and they can decrease the proliferation of human tumor cells (Reddy et al., 2005). It is a natural diet that stimulates energy since it contains the most nitrate and sugar content of any plant (Yadav et al., 2016). They are a good dietary supplement due to their high mineral, vitamin, and nutrient content, as well as their distinctive phytochemical components (carotenoids, phenolic acids, and ascorbic acid) with medical applications. Several components of this plant have antioxidant, antidepressant, antibacterial, antifungal, anti-inflammatory, diuretic, and carminative properties (Yadav et al.,2016).

Beetroot juice can also be used as a natural medicine to remove kidney and bladder stones, as well as for sexual weakness. The roots and greens are beneficial to women's health and those planning on getting pregnant. *Beta vulgaris var. rubra* had substantial tumor inhibitory effects in skin and lung cancer (Kapadia et al.,1996). These data imply that consuming beetroot may help to avoid cancer.

Recent research suggests that beetroot consumption may improve clinical outcomes for a variety of diseases, including cardiovascular disease (Mirmiran et al., 2020; Milton-Laskibar, Martínez, and Portillo 2021), hypertension (Bonilla Ocampo et al. 2018), diabetes (Aliahmadi et al., 2021), cancer (Lechner and Stoner 2019; Tan and Hamid 2021), hepatic steatosis and liver damage (Al-Harbi et al., 2021), gallbladder. Various studies have shown that betalain is effective at removing oxidative and nitrative stress by lurking 2,2-diphenyl-1-picrylhydrazyl (DPPH), lowering low-density lipoprotein (LDL), and preventing DNA damage. Betalains have also been shown to reduce cell proliferation, limit the development of new blood vessels, and induce programmed cell death and autophagy in cancer (Chen et al., 2021). Beetroot supplementation has been related to improved athletic performance because nitric oxide aids in the supplementation of glucose, oxygen, and other nutrients for greater muscle endurance (Arazi and Eghbali 2021; Macuh and Knap 2021). Various clinical research has recently indicated that beetroot juice can assist to decrease the detrimental effects of home quarantine on cardiovascular health (Volino-Souza et al., 2020).

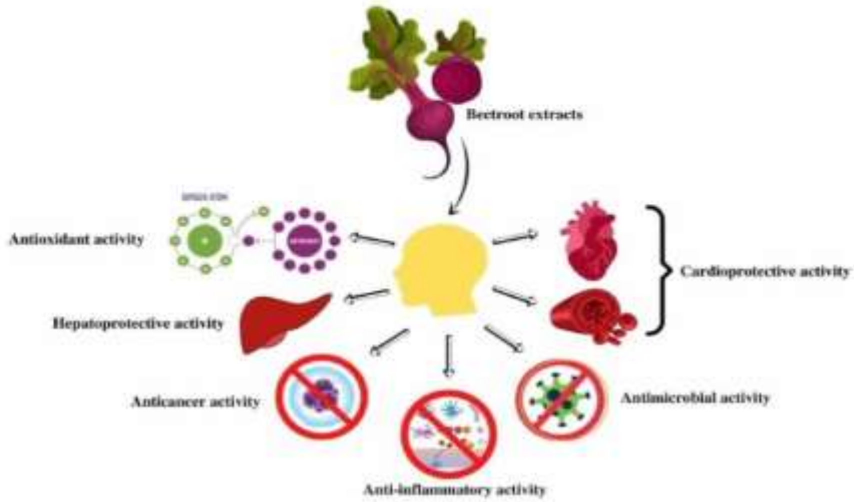

Figure 2: Bioactivities of beetroot and its extract (Bangar et al.,2022)

Application of beetroot as value added food products

Beetroot and its value-added products provide numerous health benefits and may aid in the prevention and treatment of a variety of illnesses and diseases due to their nutrients and bioactive components. As a result, beetroot is a health-promoting functional food (Bangar et al.,2022).

Beetroot-based products have been popular in the nutritional and functional food markets for many years. Their use as functional additives in various food products is gaining popularity due to their health benefits.

Beetroot is a high-nutrient, bioactive compound-rich vegetable that has traditionally been utilized in a variety of foods due to its red color. They are fractionated into various forms such as juice, pulp, pomace, powder, peels, extracts, and so on, which can then be used to develop functional food products enriched with various beetroot fractions such as baked goods like bread, cakes, cookies, biscuits, muffins; extruded snacks, ice cream; milk products like yogurt, butter curd, cream cheese, butter, paneer, milk beverages; fermented beverages, expanded snacks, sausages, meat, patties, pasta, noodles, films, and coatings, among other things. Beetroot, in addition to its coloring capabilities in various food products, is used to give potential health-promoting functions such as antioxidant and antibacterial properties.

Furthermore, the type of beetroot component percentage and the level of integration have a significant impact on the qualities of food products including beetroot. The use of various beetroot components resulted in varying types and levels of alteration in food items, with the extent of changes in product quality features mostly determined by the type of beetroot fraction. Because of interactions between the base product and the beetroot, its amount is determined by the chemical and structural properties of the bioactive components of the beetroot fraction used, which influences their structure and functionality, as well as product quality (Bangar et al.,2022).

Figure 3: Beetroot, its various fraction types and their applications in various food products (Bangar et al.,2022)

Utilization of beetroot pomace in food sectors

The processing of agricultural goods generates the most waste in the agro-based industry. Beetroot processing plants are one of the businesses that generate a huge amount of waste. According to Čanadanović-Brunet et al., (2011), beet root pomace from the juice industry (15-30%) is discarded as feed and manure, despite its high concentration of betalains and phenols.

The residual beetroot used to make the colorant has powerful antioxidant properties. Shyamala and Jamuna (2010) measured the total tannins, polyphenols, vitamin C, β-carotene, and total carotenoids in beetroot pulp waste. Shyamala and Jamuna (2010) found a significant concentration of protein (13.23 mg/100 g), 220-250 mg total polyphenols, and 40-78% antioxidant activity in methanolic extracts of beetroot pulp waste. They (Shyamala and Jamuna, 2010) also stated that beetroot pomace is a rich source of dietary fiber, particularly soluble fiber, and might be used as a supplement or for value addition. New food items and ingredients for processed foods. One such product generated from beetroot waste is a natural colorant for processed food products, which contains two colored antioxidant pigments known as red-violet betacyanins and yellow-orange betaxanthins that protect against degenerative diseases (Azeredo 2009). Natural colorants, unlike artificial colorants, play an important role in drinks and meals since they have less adverse effects. Costa et al., (2017) devised a method for producing colorant from beetroot waste. They dried the trash at 70°C and obtained flour rich in betalains, which have antioxidant properties. It was also observed that the colorant generated through this procedure remains stable for 20 days without losing its antioxidant activity. Furthermore, beetroot waste colorants are harmless and may have antibacterial properties in addition to their nutritional value.

Plant material containing phytochemicals has been reviewed in recent years with a view of discovering new natural food ingredients to increase the phytochemical potential of existing foods. Beetroot extracts have a very high phytochemical profile, which has sparked a significant increase in researcher interest in recent years, but beetroot pomace continues to struggle to find its identity, so more research can be conducted to ensure that the entire portion of beetroot can be utilized in one way or the other without discarding any of it.

Ginger: A flavor and a healer

Ginger is widely used as a culinary spice, condiment, and herbal treatment. It is a plant from the Zingiberaceae family, officially known as *Zingiber officinale Rosc*, and is native to south-east Asia (Purseglove et al., 1981). India is the world's largest producer and consumer of ginger, accounting for over 31% of total global production, followed by China, Nepal, Indonesia, Nigeria, and Thailand. It is one of the oldest known valued spices, renowned for its pungency and scent, and considered a healing gift from God by Indian Ayurvedic systems (Bijaya B Bag., 2018). It is a key dietary component in both South Asian cuisine and traditional Chinese medicine.

Ginger rhizome has long been used as a spice or herb to impart various food attributes such as flavor, aroma, food preservation, and nutritional reform, but it has also been used to treat a variety of ailments such as asthma, flu, indigestion, and gastrointestinal discomfort (Srinivasan., 2017).

Ginger grows well in tropical and subtropical climates because it cannot withstand extremely cold temperatures. When ginger is used as a vegetable or to make ginger preserve, beverages, pickles and candies the suggested harvesting time is about 4-5 months after planting, whereas when it is used to make dried ginger, bleached and dehydrated ginger, or functional products like ginger oil and oleoresin, the recommended harvesting time is around 8-10 months (Nair., 2019).

The highest ginger-producing states in India include Orissa, Kerala, Karnataka, Arunachal Pradesh, West Bengal, Sikkim, and Madhya Pradesh. Kerala contributes 33% of overall production, making it India's largest ginger producing state (Gupta., 2008). Cochin ginger and Calicut ginger are the most popular Indian ginger cultivars in the world market. India produces 6,83,000 tons of ginger per year, which accounts for over one-third of total ginger output in India. Half of that is utilized for fresh or green ginger, and the remainder is used for seed materials. Kerala is India's largest producer of dry ginger, accounting for a major portion of the export market.

Nutritional and bioactive composition of Ginger

Ginger is composed of carbohydrates (60-70%), water (9-12%), proteins (9%), lipids (3-6%), ash (8%), crude fiber (3-8%), and essential oil (2-3%). In addition to these macronutrients, it also contains critical micronutrients such as potassium, magnesium, copper, manganese, and silicon, as well as bioactive substances such as gingerols, volatile oils, and diarylheptanoids.

Ginger bioactive components have high antioxidant activity and can restore or maintain normal oxidative stress levels. According to Tanweer (2020) and Ahmad (2015), ginger leaves have a higher antioxidative potential than ginger rhizomes and ginger flowers.

Ginger and its derivatives have been recognized for their potent antibacterial, antiviral, and antifungal properties (Moon and Lee., 2018). Ginger essential oil has remarkable antibacterial properties against food-borne pathogenic microorganisms like Escherichia coli and Staphylococcus aureus. Ginger and its active components have been linked to anti-carcinogenic qualities at all stages of cancer growth, including initiation, promotion, progression, and medication resistance. Furthermore, trace levels of various additional sesquiterpenoids, alpha pinene, limonene, zigerbene, batabeasabolene, alpha paradol, farnesene, geranyl acetate, bisabolene, terpeneol, terpanes, geraniol, and monoterpenoid fraction (β-phelladrene, cineol, and citral) have been found. Ginger contains a minimal quantity of curcumin. Alkaloids, tannins, carotenoids, saponins, flavonoids, steroids, and cardinolides are also present in trace concentrations (Shrin Adel, 2010). Ginger has fibers that are both soluble and insoluble.

Ginger has long been known for its therapeutic benefits as an immune-stimulating agent, hepato-protective agent, aphrodisiac, antiemetic, anticancer, anti-platelet, anti-microbial, anti-parasitic, anti-oxidant, anti-inflammatory, and an aid in digestion (Malhotra and Singh, 2003).

Ginger has certain active components that are responsible for smooth digestion, or, more precisely, it acts as a digestive trigger. It also helps to cure constipation and other digestive disorders. Because of its unlimited therapeutic properties, it has been employed in both Indian Ayurvedic and Chinese medicine since antiquity. In Chinese medicine, it was primarily utilized for the movement of body fluids since it accelerates blood circulation throughout the body due to its wonderful stimulatory action on the heart muscle and powerful ability to dilute the blood (Zadeh and Kor., 2014).

Though excessive consumption may cause problems, a study found that it has no harmful effect on heart rate and blood pressure, and it is not associated with at least one study indicates that ginger has no effect on blood pressure, heart rate, or coagulation parameters, and it is not associated with anticoagulant drugs such as warfarin (Weidner and Sigwart, 2000). This conclusion was later confirmed with double confidence, indicating that ginger has no influence on coagulation status, pharmacokinetics, or warfarin in healthy patients (Jiang, Williams et al., 2005).

It has long been used to treat several gastrointestinal diseases and is frequently advertised as an effective antiemetic. Gingerols, the pungent compounds found in ginger rhizomes, are thought to offer antiemetic, analgesic, antipyretic, anti-inflammatory, chemopreventive, and antioxidant activities (Shukla and Singh., 2007).

They have also been proposed as treatments for a variety of illnesses, including arterial sclerosis, migraine headaches, rheumatoid arthritis,ulcers, high cholesterol, and depression. (Yi,LT et al., 2010). 6-Gingerol, 6-shogaol, and other ginger constituents limit prostaglandin production by inhibiting 5-lipoxygenase or prostaglandin synthetase (Kiuchi et al., 1992).

Applications of ginger as value added food products

Ginger is presently used in a variety of forms, including fresh, dried as *sonth* and ginger powder, pickles, ginger preserves or sweets, candies, syrup, ginger juice for producing squashes and canapés, and so on (Peter, 1996).

Ginger is widely utilized in the soft drink, baking, and meat processing industries in Canada, the United Kingdom, and the United States of America. Ginger brine is mostly used in Japan (Jiang et al., 2005).

The dried ginger is traded globally for the production of essential oils and oleoresins, which are used to make non-alcoholic beverages and vitaminized effervescent soft drinks (Peter, 1999). However, due to the pungent aroma and harsh spicy flavor of ginger, there are not many options to make processed food products from it.

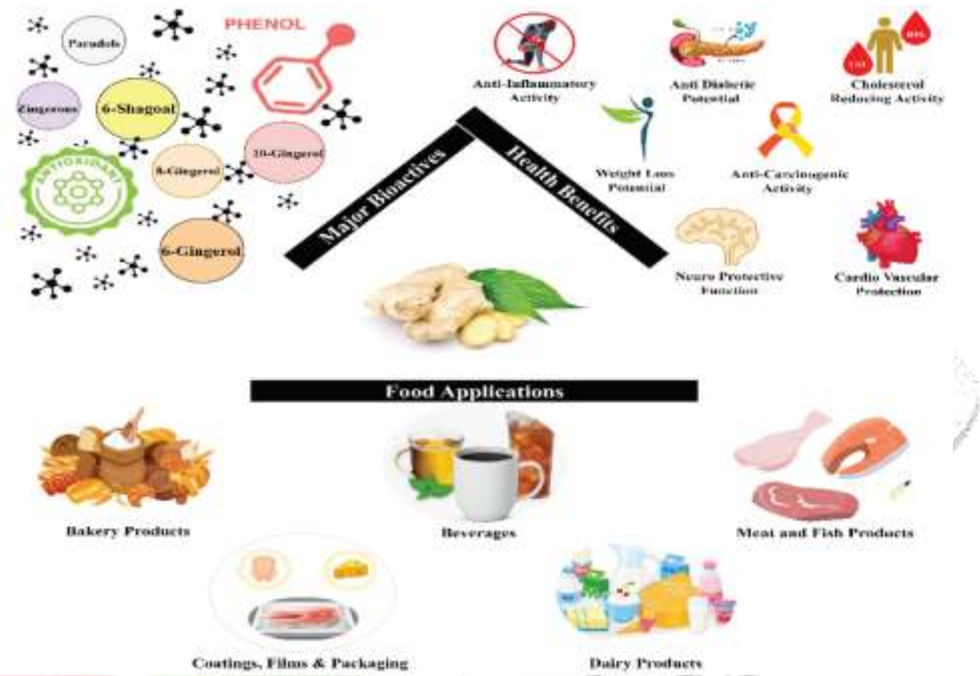

Figure 4: Major bioactives, health benefits and food applications of ginger (Shaukat, Nazir, Fallico.,2023)

Future recommendations of beetroot and ginger

The beetroot and ginger although known for their numerous nutritional and medicinal benefits, are not much preferred by the people in raw form as ginger has a pungent taste and aroma and beetroot has an earthy flavor. Therefore, development of different food products incorporating both the ingredients can increase the palatability and can be considered as an alternative way to include health promoting nutritional compounds in the diet. The products of ginger and beetroot are available separately in the market but product incorporating both are hardly available. Hence in the future, more products including both ginger and beetroot can be developed as together they can provide an excellent source of phytochemicals, antioxidants along with dietary fiber which are beneficial for the health.

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