



A REVIEW ON CONSUMPTION OF BEET ROOT FOR ATHLETES AND PATIENTS AS A FUNCTIONAL FOOD

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Abstract: Beetroot (*Beta vulgaris* L.), commonly known as chukandar, is well recognized for its natural sweetness, as it contains a high sugar content while remaining low in calories. Botanically, it is a herbaceous biennial plant belonging to the Chenopodiaceae family. Fresh beets are highly nutritious, and their green tops provide valuable nutrients such as beta-carotene, iron, and calcium. Beetroot is essentially a cool-season vegetable cultivated worldwide. It is rich in antioxidants and essential minerals like potassium, magnesium, sodium, and vitamin C, along with bioactive pigments such as betalains. The bulb of beetroot occurs in various shades ranging from yellow to deep red, with the deep red varieties being most common for human consumption—either cooked, juiced, or eaten raw in salads. Beetroot contains several biologically active compounds, including carotenoids, saponins, betacyanins, betanin, polyphenols, and flavonoids, which contribute to its potential role in cancer prevention. The primary betalain pigments in beetroot are betacyanins and betaxanthins, which serve as natural antioxidants and are used in dietary supplements aimed at preventing and managing hypertension and cardiovascular diseases. These compounds also possess antibacterial and antiviral properties and have been shown to inhibit the proliferation of human carcinoma cells. Additionally, beetroot can be processed through osmotic dehydration to produce beetroot candy, which can be incorporated into bakery products, confectionery, and ice creams, among other foods. **Keywords :** Beetroot , *Beta vulgaris*, Betalains, anti -oxidant , anti-diabetic, anti – inflammatory , Chenopodiaceae, Dietary supplement, Nutritional benefits.



Introduction :Beta vulgaris, commonly known as beet, is an edible plant belonging to the subfamily Betoideae of the Chenopodiaceae family. It is easily recognized by its distinctive and vibrant crimson-red coloration.¹ Beta vulgaris conditiva is a group of edible taproots that originated in the Middle East and have since spread across the world, including the Americas, Europe, and Asia. Beetroot is known for its numerous health-promoting properties, including antioxidant, anti-inflammatory, anti-carcinogenic, anti-diabetic, hepatoprotective, hypotensive, and wound-healing effects. Consequently, it has gained popularity as a functional ingredient in the preparation of various food products.²

Fig.1 : Beta vulgaris ³

Recent studies on beetroot supplementation, particularly those examining its blood pressure-lowering (hypotensive) and performance-enhancing (ergogenic) effects, have emphasized the key role of inorganic nitrate (NO_3^-) in mediating its physiological benefits. Several interventional studies, though limited in number, have explored the effects of beetroot and its derivatives on systolic and diastolic blood pressure, vascular and endothelial function, glucose and insulin responses, and microbiome diversity in relation to glycemic control. However, the overall results have been inconsistent. Furthermore, the observed hypotensive and hypoglycemic effects of beetroot juice have not been conclusively linked to a single causal mechanism, with similar ambiguity noted in microbial and renal studies. Beta vulgaris, commonly known as beetroot, belongs to the family Chenopodiaceae. Among its various cultivated forms, the most well-known is the purple root variety, widely recognized as the table or garden beet. Other important cultivars in India, beetroot is primarily cultivated for its use as a vegetable and for juice production. It is a rich source of vitamins A, B1, B2, B6, and C. include the sugar beet, used extensively in sugar production, and the leafy types, such as chard and spinach beet, valued as nutritious vegetables. Beetroot can be consumed in multiple ways— juiced, baked, boiled, or eaten raw. Red beets are particularly popular when roasted, pickled, added to salads, or prepared as soups, such as the traditional varieties enjoyed across Eastern and Central Europe. Unlike most fruits, beetroot primarily contains sucrose as its main sugar. For centuries, beets have also played a role in traditional medicine, especially for alleviating digestive issues and constipation.²

Dietary supplementation plays an essential role in enhancing physical performance, promoting recovery, and supporting the body's adaptation to exercise. Both amateur and professional athletes commonly use a range of supplementation strategies, including synthetic ergogenic aids and natural performance-enhancing compounds. Among these, plant-based supplements have gained growing popularity due to their potential to improve athletic performance while also providing additional health benefits.⁴



Fig.2: Juice of Beetroot ⁵

Beetroot juice is one of the most well-documented natural supplements known for its ergogenic effects. Its primary active component, nitrate, is converted in the body to nitric oxide (NO) — a vital molecule that promotes blood vessel dilation, enhances blood flow, and improves the efficiency of oxygen delivery to working muscles. Through these mechanisms, beetroot juice has been shown to boost physical performance, lower the energy cost of exercise, and support recovery following intense training. The aim of this article is to review current research on the impact of beetroot juice on physical performance, training adaptation, and its safety profile. Drawing from existing scientific literature, it will examine the mechanisms of nitrate action, their effectiveness across various sports disciplines, and potential limitations associated with long-term supplementation. Ultimately, this review seeks to provide a comprehensive evaluation of beetroot juice as a natural supplement for enhancing athletic performance.⁴

Beets are generally biennial plants characterized by a prominent taproot that may appear yellow or red. The red variety is commonly used in salads, juices, natural food coloring, and traditional medicine, and it is believed to have originated along the Mediterranean coast. Cultivated beets typically possess dark red, white, or yellow roots that are thick and fleshy, whereas wild types have brown, fibrous roots that are often swollen and woody. Beets have long been regarded as a traditional “blood-building tonic” and are widely known for their juice and medicinal properties. They are referred to by several names, including beet, chard, and spinach beet. Beetroot is easy to cultivate and consistently ranks among the top ten vegetables grown in India. Rich in minerals, nutrients, vitamins, and distinctive phytoconstituents, beetroot serves as an excellent dietary supplement with numerous health benefits. Various parts of the beetroot plant are used in medicine for their antioxidant, antidepressant, antimicrobial, antifungal, anti-inflammatory, diuretic, expectorant, and carminative effects. Athletes particularly benefit from beetroot due to its high nitrate and sugar content, which enhances energy and endurance. Interestingly, beetroot is primarily cultivated for culinary purposes—such as in pickles, salads, and juices—rather than for sugar production.¹

Beetroot (*Beta vulgaris*) is considered an alkaline food, with a pH ranging from 7.5 to 8.0. It is a nutrient-rich vegetable abundant in antioxidants and essential minerals such as potassium, magnesium, sodium, vitamin C, and betalains. It occurs in a range of colors, from yellow to deep red, with the red varieties being the most commonly consumed, whether cooked, juiced, or used raw in salads. Beetroots contain several bioactive compounds, including carotenoids, saponins, betacyanins, betanin, polyphenols, and flavonoids. They are widely cultivated for use in salads, pickles, and juices. The betalains responsible for the deep red pigmentation of beetroot are used as natural colorants in the food industry and have attracted attention for their potential health-promoting properties, particularly their antioxidant and anti-inflammatory effects.⁶

Beetroot possesses notable antimicrobial and antiviral properties and has shown the potential to inhibit the proliferation of human tumor cells. It is widely cultivated across India, from the southern hills to the cooler northern regions. As the world’s second-largest producer of vegetables, India contributes nearly 15% of global vegetable production. Major beetroot-producing states include Haryana, Himachal Pradesh, Uttar Pradesh, Maharashtra, and West Bengal. Dried beetroot can be consumed as chips, offering a healthier alternative to traditional snacks high in trans fats, or incorporated into instant foods after simple preparation. Due to its numerous health benefits, beetroot should be included in the daily diet in various forms. Therefore, effective processing and preservation methods are essential to maximize its nutritional value. With the growing awareness of health and wellness, people are becoming more conscious of the benefits and potential drawbacks of the foods they consume, leading to an increased focus on nutritious eating in recent years. In India, beetroot is primarily cultivated for its use as a vegetable and for juice production. It is a rich source of vitamins A, B1, B2, B6, and C.⁶

➤ Objectives:

- To aware about health benefits of Beetroot in enhancing Haemoglobin level in body.
- To study about an essential role of beetroot in enhancing physical performance.
- To know about beetroot in recovery, and supporting the body's adaptation to exercise.
- To study about Beetroot juice is one of the natural supplements known for its ergogenic effects.
- To study about Nitrate component in beetroot promotes blood vessel dilation, enhances blood flow.
- To study about its antioxidant, antimicrobial, anti-inflammatory, antidiabetic and anticancer properties.

➤ Names of Beetroot in other languages : ²

Bitra gacha (Bengali)

Bit (Malayalam)

Bitra (Marathi)

Beet (Punjabi)

Carkkarai vali kilanku Ceti (Tamil)

Dumpamokka (Telegu)

Salada (Gujarati)

Gajarugadde (Kannada)

➤ Historical background :

Zohary and Hopf suggested that beetroot cultivars were already being cultivated during ancient times, as indicated by references found in some Roman recipes. Beets are native to the Mediterranean region. While beetroot leaves have been eaten since prehistoric times, the root itself began to gain popularity as a food source after the French recognized its potential in the 1800s. Today, beetroot powder is commonly used as a natural coloring agent in various foods—for instance, some frozen pizzas use it to enhance the color of their tomato sauce. ²

Although yellow, white, and candy-striped (chioggia) garden beets are available in specialty markets, the deep red ruby variety remains the most popular. Outside the United States, beets are commonly referred to as beetroot. It is estimated that about two-thirds of commercially grown beetroot crops are used for canning. Historical records indicate that beetroot was first mentioned in written texts from 8th-century Mesopotamia. Aristotle also referenced the plant, and the Greek philosopher Theophrastus later compared beets to radishes. English and German sources further suggest that beetroot cultivation was widespread throughout medieval Europe, with a significant portion of the harvest being preserved through canning.²

➤ Health and nutritional benefits of beetroot :

Various medical treatises have long recommended combining natural remedies with conventional medicine to treat a wide range of ailments and diseases. Among these natural remedies, beetroot stands out as one of the

most beneficial edible plants due to its rich content of unique bioactive compounds. It contains essential antioxidants, vitamins, and minerals that exhibit antimicrobial, anticancer, and antidepressant properties, contributing to its significant health-promoting effects.²

Beetroot pigment is widely used as a natural food dye. Although it is not heat-stable and thus mainly suitable for coloring products like ice cream and confections, it remains popular because it is inexpensive and free from known allergic side effects. Beetroot juice, known for its vibrant ruby-red color, is highly nutritious and aids in blood purification. The leaves of the beet plant are also edible—beet greens are eaten like spinach, while the midribs of chard are boiled and consumed. In some rural regions of Africa, the entire leaf is cooked and eaten as a standalone dish.²

Beetroot has long been recognized for its remarkable health benefits, supporting nearly every part of the body. Regular consumption, especially in juice form, can provide numerous advantages, including anticancer activity and the ability to help regulate blood pressure. These effects are partly linked to beetroot's strong anti-inflammatory properties, which play a crucial role in preventing and managing chronic diseases such as heart disease and cancer. Furthermore, the naturally occurring nitrates in beets help lower blood pressure safely, enhance stamina, and provide essential nutrients like vitamin C, potassium, manganese, and fiber.²

➤ Application of Beetroot as natural dye:



Fig.3: Natural dyes from beetroot⁷

Natural dyes can be derived from plants, animals, and minerals. Among plant-based dyes, beetroot is a notable example. Beetroot, the taproot portion of the *Beta vulgaris* L. plant from the Chenopodiaceae family, serves as both a nutritious food and a natural dye source. It is rich in antioxidants and essential minerals, contributing to the overall growth and development of the human body. Beetroot is unique as it can be classified as both a fruit and a vegetable and is commonly consumed fresh in salads. It contains betalains, compounds known for promoting cardiovascular health, and is also valued for its medicinal properties in

treating various ailments. Additionally, beetroot's bright crimson pigment makes it a valuable natural colorant widely used in the textile industry. It is commonly known by several names, including beet, chard, spinach beet, sea beet, garden beet, white beet, and Chukander in Hindi.⁸

➤ **Activities :**

➤ **Antioxidant activity :**

The demand for processed foods has remained consistently high since their introduction. In recent years, incorporating antioxidants into these foods has become increasingly popular. This is particularly important because many processed foods are rich in fats and proteins, which require protection from oxidation to maintain freshness and quality over time. Although synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are commonly used, natural antioxidants are gaining greater recognition worldwide due to their enhanced safety and health-promoting properties. Among these, anthocyanins and polyphenols exhibit significantly stronger antioxidant activity than BHA and BHT.⁹

Moreover, in response to growing public health concerns, the main betalain pigment in beetroot—betanin—has attracted considerable attention for its potent antioxidant potential. Betanin, approved as the natural red food colorant E162, continues to be extensively studied for its antioxidant properties. Research indicates that at a pH above 4, betanin exhibits nearly twice the free radical scavenging capacity of some anthocyanins. This high antioxidant activity is attributed to the presence of phenolic hydroxyl groups and numerous unsaturated bonds within its benzene ring structure. However, further studies are needed to fully elucidate the specific active functional groups responsible for its antioxidant effects.⁹

➤ **Antitumor activity:**

Cancer continues to be one of the leading causes of death worldwide. According to reports, approximately 17.5 million people were living with cancer in 2015. Conventional treatments such as surgery, chemotherapy, and radiation therapy remain the primary methods for managing the disease. However, these treatments are often accompanied by severe side effects, highlighting the urgent need for safer and more effective therapeutic alternatives. Global studies suggest that various complementary and alternative medicine approaches may help prevent cancer while minimizing adverse effects. Beetroot is one such promising natural option. Research indicates that beetroot possesses low toxicity and may act as a chemopreventive agent capable of inhibiting the development of cancers across multiple organs.⁹

Early investigations into beetroot's anticancer potential were conducted by Govind J. Kapadia and colleagues before 1996. Their studies revealed that in ICR mice pretreated with the tumor promoter 12-O-tetradecanoylphorbol-13-acetate (TPA), oral administration of betanin—the main bioactive pigment in beetroot—significantly inhibited the formation of cutaneous and lung tumors, reducing tumor incidence by up to 60%, particularly in lung cancers. This was the first study to demonstrate beetroot's antitumor properties using an animal model. Further research showed that treatment of HepG2 liver cancer cells with betanin induced the nuclear translocation of Nrf2, leading to cancer cell death. Notably, beetroot extracts rich in betanin exhibited strong cytotoxic effects against cancer cells while leaving normal cells unaffected. These findings suggest that beetroot and its active compound, betanin, hold considerable potential as natural agents in the prevention and treatment of various types of cancer.⁹

➤ **Anti-cancer activity :**

Betalains play an active role in scavenging free radicals and may therefore help prevent the development of cancer and cardiovascular diseases. These pigments have been shown to activate a key transcription factor responsible for triggering endogenous cellular antioxidant defense mechanisms. In an experimental study, supplementation of Huh7 cells with 15 mM betalains derived from red beet led to a notable increase in cellular glutathione (GSH) levels—an essential cytosolic antioxidant known to induce cell cycle arrest and apoptosis—indicating the potential chemopreventive properties of betalains.¹⁰

Betalains extracted from *Opuntia ficus-indica* (prickly pear) fruits also demonstrated anti-proliferative effects on cancer cells. Prickly pear extracts rich in betalains significantly inhibited the growth of human ovarian cancer cells, producing effects comparable to the synthetic chemopreventive agent 4-HPR in nude mice. Additionally, these extracts reduced the proliferation of 40–60% of immortalized cervical epithelial and cervical cancer cells. Betanin, a major betalain compound, was observed to induce dose- and time-dependent apoptosis in human chronic myeloid leukemia (K562) cells, accompanied by mitochondrial membrane depolarization and the release of cytochrome c into the cytosol. These findings suggest that combining betalain supplementation with conventional drug treatments—targeting different cell cycle checkpoints (G1 and/or S phases)—could offer a promising approach to suppress tumor growth. However, the precise mechanisms through which betalains exert their anticancer effects remain to be fully elucidated.¹⁰

Several studies have demonstrated that betalains can modify the expression of genes associated with cell growth and apoptosis. The use of cancer cell lines such as K562 and MCF7 has provided a simplified, controlled, and reproducible system to explore the potential anticancer properties of betalains. However, since cell cultures do not fully replicate the complexity of tumor behavior and their interactions within a living host, the effectiveness of betalains observed in vitro may not directly translate to human clinical outcomes. Therefore, future research should focus on combining studies using human cancer cell lines with in vivo models that closely mimic human cancer physiology, as this approach would offer a more reliable assessment of the anticancer potential of betalains.¹⁰

➤ **Anti-lipidemic activity :**

Lipid-lowering drugs are commonly used for the primary and secondary prevention of cardiovascular diseases. In recent years, plant-based alternatives such as betalain-rich extracts have gained attention due to their effectiveness and minimal side effects compared to synthetic drugs. Betalains have been shown to inhibit myeloperoxidase/nitrate-induced oxidation of human low-density lipoproteins (LDL) by scavenging lipoperoxyl radicals. In a study involving volunteers who consumed prickly pear fruit, betalains were detected in their LDL, indicating their potential role in protecting LDL from oxidative modification.¹⁰

Administration of *Amaranthus tricolor* extracts containing betalains at doses of 200 and 400 mg/kg body weight to diabetic rats significantly reduced blood cholesterol, triglyceride, and LDL levels while increasing high-density lipoprotein (HDL) levels. Similarly, consumption of betalain-enriched beet crisps led to a significant reduction in serum glucose, atherogenic index, isovaleric acid concentration in the caecum, and body weight in rats. In another study, feeding hypercholesterolemic rats with 300 mg/kg (body weight) of red pitahaya extracts rich in betalains lowered total cholesterol by 43.45%, likely by enhancing bile acid excretion. Furthermore, betalains were found to suppress short-chain fatty acid production and prevent increases in serum total cholesterol in dyslipidemic rat models.¹⁰

In vivo studies conducted on obese individuals revealed that betalains derived from red beet juice and chips inhibited neutrophil oxidative metabolism, suggesting their potential application in managing hyperlipidemia and related cardiovascular conditions.¹⁰

➤ **Anti-microbial activity :**

Betalains have been reported to exhibit notable antimalarial and antimicrobial properties. Betalain-rich *Amaranthus spinosus* demonstrated significant antimalarial activity in mice, attributed to its high levels of betanin and amaranthin, which can chelate essential intracellular cations (Ca^{2+} , Fe^{2+} , and Mg^{2+}) and inhibit the choline transport system of parasites. Similarly, extracts of *Opuntia matudae* containing betalains were shown to suppress the growth rate of *Escherichia coli*.¹⁰

Beetroot pomace also exhibited antimicrobial potential by producing zones of inhibited growth in *Salmonella typhimurium*, *Staphylococcus aureus*, and *Bacillus cereus*. It was further found to inhibit several Gram-negative bacteria, including *E. coli*, *Pseudomonas aeruginosa*, *Citrobacter freundii*, *Citrobacter youngae*, *Enterobacter cloacae*, and *S. typhimurium*, with *S. typhimurium* and *C. freundii* being the most sensitive species .¹⁰

Moreover, betalain-rich extracts from red pitahaya exhibited a broad antimicrobial spectrum, effectively inhibiting Gram-positive bacteria (*B. cereus*, *S. aureus*, *Enterococcus faecalis*, *Listeria monocytogenes*) at 7.8 mg/mL; Gram-negative bacteria (*E. coli*, *Proteus mirabilis*, *P. vulgaris*, *P. aeruginosa*, *Salmonella typhi* Ty2, *Yersinia enterocolitica*, *Klebsiella pneumoniae*, *Enterobacter cloacae*, *E. aerogenes*) at 15.6–62.5 mg/mL; yeasts (*Candida albicans*, *Rhizoctonia solani*) at 125–250 mg/mL; and molds (*Fusarium oxysporum*, *Cladosporium herbarum*, *Botrytis cinerea*, *Aspergillus flavus*) at 500 mg/mL.¹⁰

The antimicrobial activity of betalains is likely related to their disruptive effects on microbial cell structure, function, and membrane permeability, ultimately leading to cell death. Although betalains display activity against a wide range of microorganisms, detailed studies on their cellular and molecular mechanisms of action remain limited. Therefore, future research should focus on elucidating the precise pathways involved in the antimicrobial effects of betalains.¹⁰

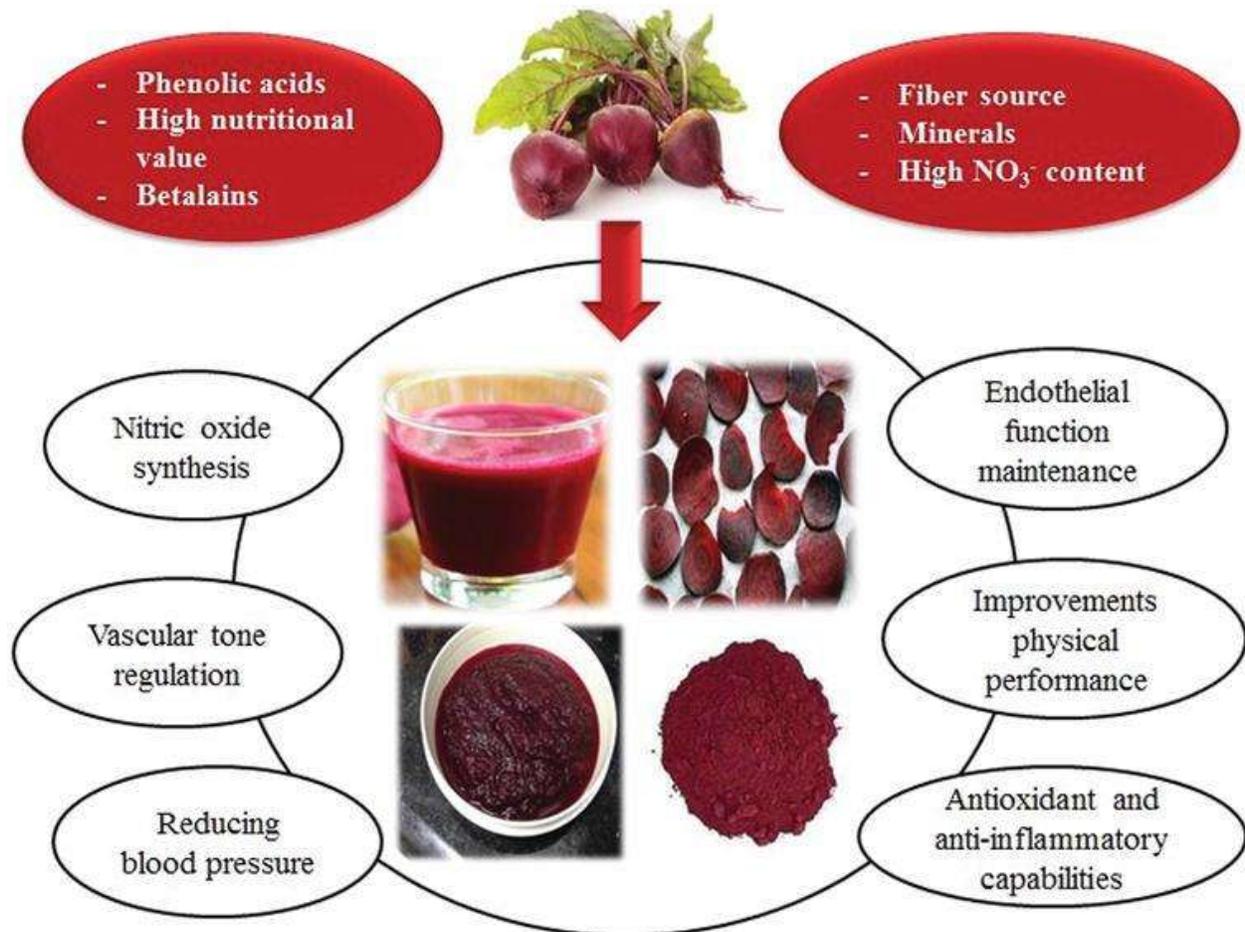


Fig.4 : Biological activities of Beetroot ¹¹

➤ Description:

Red beets are a low-fat, moderately caloric food rich in soluble fiber, carbohydrates, proteins, and natural sugars. They contain essential vitamins such as A, C, E, and K, as well as strong antioxidants including betalains, phenolic compounds, carotenoids, flavonoids, and folic acid. Additionally, they provide several B vitamins (B1, B2, B3, B5, and B6) and bioactive compounds like alkaloids, tannins, amino acids, and saponins. Beetroot is also an excellent source of vital minerals such as potassium, magnesium, sodium, phosphorus, manganese, iron, zinc, copper, boron, silica, and selenium, which is crucial for bone health.¹²

The chemical composition and nutritional value of red beetroot vary depending on the plant's variety and part (leaf, stem, root, or peel). The leaves are richer in carotenoids than the tubers due to the accumulation of α -carotene, β -carotene, and β -cryptoxanthin in the chloroplasts. Beetroot leaves are known to lower blood pressure and serve as a significant source of polyphenols. When combined with betalains, these compounds exhibit powerful antioxidant and radical-scavenging properties. Betalains are the key bioactive pigments in beetroot, divided into two groups: betacyanins (purple pigments) and betaxanthins (yellow to orange pigments). Betalains—particularly betacyanins—have demonstrated antioxidant, anti-inflammatory, anticancer, hepatoprotective, anti-lipidemic, and antibacterial properties. They can inhibit the growth of human cancer cells and suppress in vitro proliferation of cervical, ovarian, and bladder cancer cells. Regular beetroot consumption has been linked to reduced incidences of esophageal, colon, liver, lung, and skin cancers.¹²

Due to their natural color, high solubility in water, and lack of toxicity, betalains are widely used as food colorants. Red beetroot is the primary commercial source of these pigments, which help enhance the flavor and appearance of foods such as soups, sauces, desserts, candies, and cereals. Beetroots also contain fiber, vitamin C, potassium, and manganese—nutrients that support muscle function, digestion, and overall energy metabolism by optimizing adenosine triphosphate (ATP) utilization. Dietary fiber in beetroot aids digestion, prevents constipation, and protects against colon cancer. The carotenoids present in beetroot help prevent macular degeneration and reduce the risk of cataract formation. Beetroot's vitamins and minerals support kidney and liver function, combat fatty liver associated with alcohol use, protein deficiency, or diabetes, and help purify the blood. Its nutrients also contribute to stronger bones.¹²

Recent clinical studies have shown that both short- and long-term beetroot juice consumption can improve blood pressure and circulation. Beetroot juice demonstrated a greater blood pressure-lowering effect in hypertensive patients compared to healthy individuals. This may be due to increased activity of erythrocytic xanthine oxidoreductase (XOR), an enzyme involved in converting nitrite (NO₂) to nitric oxide (NO). Improvements in vascular health were also observed, including reduced arterial stiffness and enhanced flow-mediated dilation after six weeks of nitrate-rich beetroot juice supplementation. The physiological benefits of beetroot are closely associated with its nitrate content, which supports cardiovascular health. Additionally, studies have shown that beetroot juice exerts a hypoglycemic effect, significantly reducing blood glucose levels ($p = 0.004$) and improving insulin and glycemic responses. These effects are largely attributed to beetroot's bioactive compounds such as polyphenols, flavonoids, and nitrates. Improvements in lipid profiles further complement its role in managing glycemic disorders.¹²

➤ **Nutrition profile of Beetroot :**

Red beets are considered a true superfood due to their wide range of nutrients, including essential vitamins (A, C, E, K, and B complex), minerals such as potassium, zinc, sodium, phosphorus, calcium, and magnesium, as well as folic acid (Table 1). Their chemical composition (%) typically consists of moisture (87.58), dietary fiber (2.8), fat (0.16), protein (1.61), ash (1.08), and carbohydrates (9.56). However, factors such as genetic variation, cultivation methods, harvesting conditions, and environmental factors can influence the nutritional composition of beets. The distribution of these nutrients also differs among various plant parts—peel, stem, root, and leaf. Beet leaves are particularly rich in carotenoids, including alpha- and beta-carotene, which accumulate in chloroplasts.¹³

The micronutrients in beetroot contribute to cancer prevention and help regulate blood pressure, supporting cardiovascular health. Additionally, red beets contain a high concentration of antioxidants, betalains, and phenolic compounds, all of which exhibit significant health-promoting properties. Phenolic acids (such as caffeic, syringic, and ferulic acids), flavonoids (including rhamnocitrin, rhamnetin, and kaempferol), and amino acids (such as threonine, valine, cysteine, methionine, and isoleucine) are especially abundant in red beetroot.¹³

Nutrients	Average Value
Fats	0.3 ± 0.1%
Carbohydrates	7.59 ± 0.4%
Protiens	1.35 ± 0.2%
Deitary Fibres	1.9 ± 0.2%
Ash	1.4 ± 0.2%
Moisture	87.4 ±0.3%

Fig. 5 : Nutrient composition of Beetroot¹⁴

➤ **Blood Pressure lowering Effect:** Hypertension is a major global health concern with a high prevalence and serious complications, including cardiovascular disease and chronic kidney disease. Globally, the age-standardized prevalence of hypertension among adults is estimated to be 31.1%.

Several complementary and alternative medicine approaches—such as dietary supplements, functional foods, traditional herbs, and meditation—are commonly used to help manage hypertension. Beetroot (*Beta vulgaris*) has gained attention as an ergogenic compound and a multitargeted supplement with potential benefits in vascular dysfunction, atherosclerosis, cardiorespiratory disorders, and diabetes. Owing to its high inorganic nitrate (NO_3^-) content, beetroot is also considered a promising complementary treatment for hypertension.¹⁵

Nitric oxide (NO) is a naturally produced molecule in the body that plays a vital role in regulating blood pressure. Reduced NO production is linked to hypertension, cardiovascular disorders, and erectile dysfunction. It supports vascular health by enhancing blood vessel flexibility and promoting vasodilation, which help maintain normal blood pressure. Additionally, NO contributes to lowering oxidative stress, further protecting cardiovascular function.²⁴

➤ **Improve exercise performance :**

In recent years, interest in the role of various nutrients in enhancing athletic performance has grown significantly . Among these, nitrate-rich beetroot has gained particular attention for its beneficial effects on physical performance. Dietary nitrate is known to break down into nitrite and subsequently convert into nitric oxide (NO) and other bioactive nitrogen intermediates, which positively influence athletic performance . However, it is important to note that NO can also form N-nitroso compounds (NOCs) through secondary reactions, necessitating cautious consumption of beetroot . Numerous studies have so far examined the effects of beetroot on exercise performance across a wide range of populations.¹⁶

➤ **Health promoting properties :**

Red beetroot is a rich source of bioactive compounds with strong antioxidant potential, making it highly valued as a functional food or “food medicine.” Numerous in vitro and pre-clinical studies have demonstrated its wide range of health-promoting properties, including antioxidant, anti-stress, antidepressant, anticancer,

antimutagenic, anticarcinogenic, and radioprotective effects. Additionally, red beet exhibits antihypertensive, antihypercholesterolemic, antihyperglycemic, hematopoietic, antibacterial, anti-inflammatory, diuretic, antinephrotoxic, hepatoprotective, antiproliferative, and immunomodulatory activities. Regular consumption of red beetroot may also help protect against age-related diseases. To maximize these benefits, beetroot can be consumed in various forms—raw, juiced, in salads, boiled, baked, as chips, dried, or incorporated into a variety of dishes.¹⁷

Recent studies have shown that consuming beetroot—whether as juice or in fortified foods like supplemented bread—has beneficial physiological effects that may improve clinical outcomes in various conditions, including hypertension, atherosclerosis, neurodegenerative disorders, and type 2 diabetes. Owing to its rich content of B vitamins, beetroot also supports brain health by enhancing blood flow to the brain, thereby helping to reduce the risk of dementia and memory loss.¹⁷

➤ **Addition of Beetroot in food products :**

Beetroot, besides being consumed fresh, is an important vegetable in the food industry. It is widely used to produce dried and frozen products, non-concentrated and concentrated juices, as well as natural colorants (betalains) added to various food formulations. In many countries, interest in naturally preserved foods is increasing. Lactic fermentation is one such natural preservation method, enabling the production of foods with enhanced safety, extended shelf life, and high nutritional value.²³

➤ **In milk and milk products :**

Beetroot, in various forms such as paste, juice, puree, powder, or extract, can be effectively incorporated into dairy products like ice cream, sherbet, curd, butter, cream cheese, yogurt, and milk-based beverages. Its addition not only improves the overall quality of these products but also imparts a vibrant, appealing color and enhances consumer acceptance.¹⁸



Fig .6 : Beetroot milk product¹⁹



Fig. 7 : Beetroot milk ²⁰

➤ Gels , juices and beverages :



Fig .8 : Beetroot gels²¹

Beetroot pulp can also serve as a functional ingredient in probiotic milk gels, enriching them with improved antioxidant properties.¹⁸



Fig. 9 : Beetroot beverages ²²

The consumption of functional beetroot gel represents a novel nutritional approach to deliver high levels of bioaccessible nutrients that may help improve cardiovascular health and enhance exercise performance. In milk-based beverages such as fermented buttermilk, low-calorie lassi, rayeb milk, and yogurt drinks, incorporating beetroot in various forms has been shown to reduce acidity while enhancing antibacterial activity and antioxidant properties.¹⁸

➤ **Meat and meat products :**

In meat products such as chicken meat, patties, burgers, meatballs, turkey and pork patties, as well as fresh and fermented beef, pork, and chicken sausages, and chicken legs, beetroot is utilized as a functional ingredient. It not only imparts an appealing red color but also enhances the nutritional, bioactive, sensory, and storage qualities of these products. This is attributed to beetroot's rich bioactive composition, including betalains, carotenoids, phenolic acids, flavonoids, nitrates, nitrites, vitamins, and minerals, which provide strong antioxidant and antimicrobial properties. Incorporating beetroot in various forms into meat and sausage products also helps lower pH levels and improve storage stability.¹⁸

➤ **Cosmetic Products:**

• **Beetroot Lipbalm:**

Herbal lip balm, crafted from botanical ingredients such as herbs, plant oils, and beeswax, serves as a natural alternative to conventional lip products. It offers nourishing, moisturizing, and soothing benefits for the lips, typically without relying on harsh chemicals or artificial fragrances. Thanks to their gentle yet effective properties, herbal lip balms are popular among those seeking a more holistic approach to lip care. All the

ingredients in natural lip balms are safe for use and offer beneficial nutrients that help keep the lips healthy. Stability testing indicates that the lip balm is suitable for long-term use, maintaining its integrity across various temperatures. It has also demonstrated effective lip protection and hydration without causing irritation, making it a reliable natural alternative to synthetic cosmetics. Formulated with non-toxic, plant-based ingredients, the product not only supports moisture and nourishment but also promotes environmentally sustainable cosmetic practices.²⁵



Fig.10: Beetroot Lipbalm.²⁶

➤ **Beetroot Cream:**

Beetroot is beneficial for the skin as it helps reduce sunspots, dark spots, and acne scars. It is also commonly used as a natural colorant in face creams, body lotions, and lip balms. Therefore, it plays main role in cosmetic creams.²⁷



Fig. 11: Beetroot moisturizing Cream.²⁸

➤ **Conclusion :**

In conclusion, beetroot juice, being rich in dietary nitrate, elevates the levels of nitrate, nitrite, and biologically active nitric oxide (NO) in the blood. NO plays a crucial role in promoting vasodilation. The improvement in exercise performance appears to be linked to enhanced oxygen utilization efficiency. Studies have shown that beetroot juice can improve athletic performance in healthy individuals, though the extent of benefit may vary based on individual aerobic fitness levels. Moreover, dietary nitrate supplementation may positively influence exercise performance in certain patient groups. Nonetheless, larger and well-controlled clinical trials are needed to confirm its overall therapeutic effectiveness.

This review concludes that beetroot extract possesses significant potential as an anticancer agent. Widely recognized for its versatility and high nutritional value, beetroot has a long history of medicinal use. It offers numerous health-promoting properties, including antioxidant, antidepressant, antimicrobial, and anti-inflammatory effects, among others.



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