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A SYSTEMATIC OVERVIEW ON BEET ROOT

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ABSTRACT: *Beta vulgaris* is commonly called beetroot. This is the taproot portion of the beet plant. There are types of beets grown in Egypt, India, Europe and Ukraine. It is used in the traditional Indian system of medicines. *Beta vulgaris* Linnaeus is among the top ten most powerful vegetables as an excellent source of phytochemicals. It is also known for its high content of biologically active substance such as betalains, polyphenolic compounds, vitamin, carotenoids and other nutrients including sodium, potassium, and magnesium. Some parts of this plant are used in the medicinal system as antioxidant, antidepressant, antimicrobial, antifungal and anti-inflammatory, diuretic, expectorant and carminative. Beet (*Beta vulgaris* L.) as a health-promoting functional food may be potentially beneficial in cancer. As a source of polyphenol, flavonoids, dietary nitrates and other beneficial nutrients, beetroot supplementation may provide a holistic way to prevent cancer and manage the side effects of chemotherapy.

INTRODUCTION: *Beta vulgaris*, commonly known as beet, is an edible plant belonging to the sub family Betoideae with in the Chenopodiaceae family. This plant is characterized by its vibrant crimson color [1, 3]. It is an erect annual herb with a tuberous root [3]. Beets are typically biennial, featuring a taproot that can be either yellow or red. The red root is often used in salads, juices, food coloring, and traditional medicine, and it originally emerged along the Mediterranean coast [9]. Cultivated beets have dark red, white, or yellow roots that are swollen and fleshy, while wild varieties have brown, fibrous roots that may be swollen and woody [2].

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Beets are traditionally referred toasa "blood building tonic" [8]. They are well-known for their juice and medicinal properties and are recognized by various names, including beet, chard, and spinach beet [3]. Additionally, beetroot is easy to grow and consistently ranks among the top 10 vegetables cultivated in India [4]. Beetroot is a fantastic dietary supplement because it's packed with minerals, nutrients, and vitamins, along with unique phytoconstituents that offer various medicinal benefits.

Different parts of the beetroot plant are utilized in medicine for their antioxidant, antidepressant, antimicrobial, antifungal, anti-inflammatory, diuretic, expectorant, and carminative properties. Athletes particularly benefit from beetroot as it contains high levels of nitrates and sugars, making it an effective energy booster. Interestingly, beetroot is primarily grown for food purposes like pickles, salads, and juices rather than for producing sugar.

The main sugar present in beetroot is sucrose, accompanied by only minimal quantities of glucose and fructose. This is particularly beneficial since fructose can negatively impact exercise performance. Therefore, the higher content of sucrose is more desirable, especially for sports drinks, as it supports better energy levels during physical activity. Beetroot (*Beta vulgaris*) has an alkaline nature, with a pH ranging from 7.5 to 8.0, and is celebrated for its health benefits, particularly its potent antioxidant properties. It is rich in vitamin C and several B vitamins (B1, B2, B3, B6, B12), while its leaves are an excellent source of vitamin A. Additionally, beetroot juice is often used as a natural remedy for sexual weakness and to help expel kidney and bladder stones [3].

You can enjoy beetroot in various ways: raw, boiled, steamed, or roasted. The red variety is especially rich in essential minerals like magnesium, manganese, sodium, potassium, iron, and copper. In summary, beetroot is a versatile and nutritious food that supports overall health and athletic performance [4]. Potassium is essential for normal neuron and muscle function, making it a crucial mineral for overall health. Additionally, vitamin B plays a significant role in cleaning the liver and blood, and it contains naturally occurring minerals that contribute to bone strength. Because of these properties, beetroot has been traditionally used in Arab medicine to treat various illnesses. During pregnancy, beetroot can be consumed as a salad because it supports the growth of the fetus. It is rich in silica, which helps the body effectively utilize calcium, promoting strong and healthy bones, skin, and hair. In summary, beetroot is not only nutritious but also beneficial for both general health and specific conditions like pregnancy [8].

Recent studies show that beets contain bioactive compounds that make them a functional food, meaning they provide health benefits beyond just nutrition. In addition to proteins, carbohydrates, fats, amino acids, and fiber, beetroot is rich in vitamins, nitrates, polyphenolic compounds, and betalains [1]. The vibrant red color of beetroots comes from betalains, specifically betacyanins and betaxanthins [3]. These betalains are powerful antioxidants, helping to reduce oxidative stress by removing harmful reactive oxygen species from the body. This antioxidant effect is likely enhanced by the presence of other compounds in beetroot, like polyphenolic compounds. In simple terms, beets are not just good for you; they also help protect your body from damage caused by free radicals [1]. The global production of vegetables has experienced remarkable growth, soaring from 682.43 million tons in 2002 to an impressive 1088.9 million tons by 2018. Specifically, the production of root and tuber vegetables rose from 8.99 million tons in 2008 to 10.53 million tons in 2018, with Egypt being the top producer in North Africa, contributing nearly 5221 tons. Fermenting beetroot with lactic acid bacteria helps prevent the breakdown of its beneficial components.

For example, fermented beetroot juice can maintain its anti-mutagenic properties for up to 30 days when refrigerated. The juice is also a good source of carbohydrates, which makes it an excellent medium for fermentation by probiotic strains like *Lactobacillus acidophilus*, *Lactobacillus plantarum*, *Lactobacillus casei*, and *Bifidobacterium bifidum*. During fermentation, these lactic acid bacteria produce vitamins that improve the nutritional value of the juice. They also create lactic acid, which lowers the pH of the juice, helping to inhibit the growth of spoilage microorganisms and extending its shelf life [9].

Historical Background: Beets have their roots in the Mediterranean, where they have been appreciated since ancient times. While the leaves were enjoyed long before written records, beetroot was primarily valued for its medicinal properties until the French discovered its culinary potential in the 1800s. Today, beet powder is a popular coloring agent in various foods; for instance, it's often used in the tomato sauce of some frozen pizzas. The classic garden beet is known for its striking deep red ruby color, but you can also find unique varieties like yellow, white, and candy-striped beets in specialty markets. In many parts of the world outside the United States, these vibrant vegetables are referred to as beetroot. Interestingly, around two-thirds of the commercial beet harvest is processed and canned.

The history of beets can be traced back to the 8th century in Mesopotamia, where they were first mentioned in writing. The Greek philosopher Theophrastus noted their similarity to radishes, and

Aristotle also referenced the plant. Later historical accounts from England and Germany reveal that beetroots were widely cultivated throughout Medieval Europe [4].

Origin of Beetroot: Beetroot comes from a wild plant called *Beta vulgaris* L. ssp. maritima, which likely mixed with another plant, *Beta patula*. It probably started growing in Europe, and the earliest types of beetroots had long roots, similar to carrots. Beetroot, sugar beet, and palak all belong to the same plant family *Beta vulgaris* and can be grown together. The ancient Babylonians were the first to use beets for different purposes. Greeks and Romans valued the root for its health benefits and used the leaves as vegetables. As time went on, beetroot became important in medicine. In England, beetroot juice or broth was often suggested as easy-to-digest food for older people or those who were weak. In mythology, there's a story that Aphrodite ate beets to keep her beauty. Additionally, in Africa, beets are used as a remedy for cyanide poisoning, showing their usefulness throughout history [5, 7].

Worldwide Beetroot Production: Beetroot is cultivated all around the world. In 2014, global production reached an impressive 269,714 million tonnes. France led the way with about 37,844,567 tonnes, while Russia produced around 33,513,367 tonnes of beetroot that same year. Other significant producers include the United States, Poland, Germany, Turkey, Egypt, various countries in Europe, Ukraine, and China. In Poland, beetroot is one of the most popular root vegetables, with around 314 thousand tonnes produced in 2014. This marked a 5.3% increase from the previous year, according to the Central Statistical Office. Overall, beetroot enjoys a strong presence in European cuisine and agriculture [6].

Varieties of Beetroot: There are several notable varieties of beetroot, including Crimson Globe, Early Wonder, Detroit Dark Red, and Crosby Egyptian. The Detroit Dark Red beetroot is known for its uniform and smooth roots, featuring deep red flesh that is rich in color. On the other hand, Crimson Globe beetroot has medium-dark red flesh and slightly prominent shoulders, giving it a distinctive appearance. Crosby Egyptian beetroot stands out with its dark purplish interior and subtle zones, along with a flat globe shape. This variety reaches maturity approximately 60 days after sowing. Lastly, Early Wonder beetroot is characterized by its flattened root, green leaves, and smooth- textured round shoulders. It has dark red flesh with lighter red zones, making it visually appealing as well. Each of these varieties offers unique features that contribute to their popularity among growers and consumers alike [6].

Other Language Names of Beetroot: *Bita gacha* (Bengali), Bit (Malayalam), Bita (Marathi), Beet (Punjabi), Carkkarai vali kilanku ceti (Tamil), Dumpamokka (Telegu), Salada (Gujarati) and Gajarugadde (Kannada) [4].

Cultivation:

Cultivar: The selection of beetroot cultivars is affected by several factors, including the time it takes for them to mature, the size and shape of the roots, the size of the foliage, the smoothness of the outer surface, the color of the interior, and the extent of zoning. Hybrid (F1) cultivars, particularly those suited for summer production, present numerous benefits. While these hybrid beets tend to be pricier, their advantages make them worthwhile for cultivation. They generally exhibit superior quality, are more resilient to extreme heat, and maintain a more consistent shape. Additionally, hybrids tend to yield more and possess better internal coloration. They also perform better in taste tests, especially when grown out of season [5, 7].

Climatic Requirements:

Temperature: Beetroot is a tough plant that can handle cooler temperatures and prefers a cool climate [5]. It grows best in the spring and autumn, but it can also do well in summer at higher altitudes and in winter at lower altitudes [7]. Even though beetroot can survive in warmer weather, the best quality in terms of color, texture, and sugar content

of the roots comes from cooler temperatures. When it gets too hot, beetroot may develop zoning, which means you'll see alternating light and dark red rings in the roots [5]. On the flip side, very cold weather can slow down or stop the plant's growth [7]. If the temperature stays between 4.5 to 10.0°C for 15 days, it can cause the plant to bolt, which is when it starts to flower instead of growing roots. Beetroot also needs plenty of sunshine to grow its storage roots properly [5]. The seeds can germinate at soil temperatures from 4.5 to 30°C, but they grow best when the temperature is between 18 to 24°C [7].

Rainfall: Beetroot needs plenty of water for quick growth, with requirements varying from 2 mm on cold winter days to 8 mm on hot summer days [7].

Soil Requirements: Beetroot grows best in well-drained, loose soils, like loamy or sandy types. Heavy clay soils can cause problems, leading to poor germination and uneven crop stands due to crust formation after rain or irrigation. In such soils, the roots may become misshaped and struggle to develop properly. Beetroot thrives in soil with a pH between 5.8 and 7.0 but can tolerate up to 7.6. Acidic soils can cause nutrient deficiencies, so it's better to avoid them or add lime to raise the pH. While mature beets can handle some salinity, seedlings are more sensitive to it [7].

Soil Preparation: The seedbed needs to be thoroughly prepared by ploughing to a depth of 15 to 20 cm to break up any clumps. It's important for the soil to be as level as possible, have a good crumb structure, retain adequate moisture, and be free of any unrotted plant debris [7].

Land Preparation and Sowing: Beetroot, being a cool-season crop, is typically grown during winter in plains and as a spring-summer crop in hilly areas around March and April. In the plains, sowing occurs between September and November. The land should be ploughed thoroughly to achieve a fine tilth, ensuring it is loose and friable, with all clods removed. It's recommended to incorporate well-decomposed farmyard manure during the final ploughing. The soil is then shaped into flat beds or ridges and furrows. Water-soaked seed balls containing 2 to 6 seeds are planted 2.5 cm deep in rows spaced 45-60 cm apart and 8-10 cm within the rows. For one hectare, about 5-6 kg of seeds are needed. Staggered sowing every 1-2 weeks helps maintain a consistent supply of roots throughout the growing season [5].

Seed Production: Beetroot has no annual tropical varieties; all cultivars are temperate biennial types. Seed production occurs in hilly areas at elevations of 1400 meters. A temperature of 4.4-7.7°C for 6-8 weeks is needed for flower initiation. The root-to-seed method is used, where seeds are sown in July, and roots are harvested in November-December. Selected tubers are transplanted at 60 x 45-60 cm spacing. Harvesting happens in June-July. Due to self- incompatibility, an isolation distance of 1000 meters is required for certified seed production and 1600 meters for breeder seeds, with an average yield of 2.0 t/ha [5].

Aftercare: Thinning is crucial when multiple seedlings sprout from a single seed. For successful germination and growth, maintaining moist soil is vital. In the North Indian plains, crops typically receive about 5-6 irrigations in summer and around three in winter. To keep the field free of weeds, light hoeing is done during the early growth stages. Additionally, to support the swollen roots, earthing up is performed by covering them with soil [5].

Irrigation: The soil must remain consistently moist to a depth of 20 to 25 cm. Young seedlings need light daily watering until they sprout, with each irrigation providing about 30 mm of water. Fluctuations in soil moisture can lead to poorly formed roots with many small hairs or side roots [7].

Fertilization: A consistent supply of nitrogen, phosphate, and potassium is vital for high yields and quality. Apply 300 to 400 kg/ha of nitrogen sources like limestone or ammonium nitrate in 2 or 3 doses, with 150 kg/ha at planting and the rest when plants are 10 to 15 cm tall. Use 500 to 600 kg/ha of superphosphate and 200 to 300 kg/ha of potassium chloride before sowing, or a 2:3:2 mix at 1000 to 1200 kg/ha. Adjust based on soil analysis, as excessive compost and manure can lead to unattractive side roots [7].

Weed Control: Weeds should be managed before they can compete with beet seedlings. It's important to remove all weeds between the rows by hand to protect the roots. Chemical control is also an option

through herbicide application, but be sure to follow the instructions on the label carefully [7].

Pests and Diseases: In beetroot cultivation, pests like leaf miners, web worms, and semi loppers, along with diseases such as Cercospora leaf spot, downy mildew, and viral infections, can cause significant damage [5].

Disease Control:

A. Cercospora Leaf Spot (*Cercospora beticola*): This common fungal disease in beetroots causes small, round spots about 3 mm in diameter on the leaves, flowers, and seeds. The spots start brown with a dark purple border and later turn grey in the center, with the tissue eventually falling out as they age.

Control:

1. Implementing crop rotation strategies
2. Treating seeds with approved chemicals
3. Preventing overwatering of plants

B. Downy Mildew

(*Peronospora schachtii*): This seed-borne disease can affect crops early in the season. Infected plants show yellowing leaves that curl downwards and later turn brown. A grey fungal growth appears on the undersides of the leaves, and flowers and the crown can also become infected.

C. Brown Rust (*Uromyces betae*): Infected plants can be identified by the presence of numerous orange or red-brown pustules on their leaves.

Control: Control measures are typically unnecessary as the disease rarely leads to significant damage.

D. Actinomyces Scabies: Beetroots affected by scab show rough, uneven scabs on their surfaces. This disease is common in soils that have high lime content.

Control: Conduct a soil analysis to assess the lime levels and seek guidance based on the results.

E. Root Rot, Damping-off (*Phoma betae*): The disease is often found in compact soil, leading to weak germination. Affected seedlings may wilt, turn yellow, and die, with blackened roots. Those less impacted produce small, malformed beetroots.

Control:

1. Seeds should be sown exclusively in well-structured soils.
2. Treat seeds with thiram before planting.
3. Implement crop rotation practices.
4. Ensure the crop receives adequate boron.
5. Plant at the appropriate time and avoid excessive depth.

Heart Rot: This condition results from a lack of boron. Heart rot is marked by black spots on the surface of the root and the presence of cracks. If you cut the beetroot open, you can see black blotches in the flesh.

Control: It is recommended to use resistant varieties for planting [7].

Harvesting: Harvest maturity Beetroot is typically harvested when the roots reach a diameter of 3 to 5 cm, although most are collected at 5 to 7.5 cm.

Harvesting Methods: The crop can be lifted by hand or mechanically, especially in large-scale operations, using a machine that extracts the roots from the soil while cutting off the leaves. For beetroots intended for fresh market sales, the leaves are left intact. It's important to carefully pull the roots from the soil and handle them gently to minimize bruising and damage [7].

Post Harvest Handling: If needed, the roots can be washed right away.

1. Sorting and Grading: Remove all diseased and mechanically damaged roots. If selling with tops, discard old or damaged leaves. Grade beetroot by size.

2. Packing: After washing, pack in crates or cartons and store in a cool, dry place. Sometimes packed in pockets.

3. Storage: Keep the environment dry to prevent fungus, maintaining a temperature of 0°C and 90% humidity.

4. Transport: Use well-ventilated vehicles at cool temperatures to avoid fungal issues, ensuring temps stay above 0°C to prevent cold wilting.

5. Marketing [7].

Chemical Composition or Nutritional Profile of Beetroot: Red beets are a true superfood packed with a wide range of nutrients, including vitamins A, C, E, K, and B, as well as minerals like potassium, zinc, sodium, phosphorus, calcium, magnesium, and folic acid [6]. They are rich in phenolic compounds, betalains, and antioxidants, including coumarins, carotenoids, sesquiterpenoids, triterpenes, and various flavonoids such as astragalin, tiliroside, rhamnocitrin, kaempferol, and rhamnetin, all of which offer numerous health benefits. Additionally, beetroot contains bioactive compounds like alkaloids (Ipomine, calystegine B1, B2, B3, and C1), tannins, and both essential and non-essential amino acids, including methionine, leucine, isoleucine, cysteine, histidine, arginine, valine, and threonine. The chemical makeup of red beetroot can vary depending on the cultivar [11], influenced by factors such as genetics, harvesting conditions, and environmental factors [6]. The distribution of nutritional components also differs among the plant's anatomical parts (leaves, stems, roots, and peels). For example, carotenoids are more prevalent in the leaves than in the tubers due to their accumulation in chloroplasts [11]. The micronutrients found in beetroot are known to help combat cancer and reduce blood pressure, both of which are vital for maintaining cardiovascular health [6]. Conversely, beetroot serves as a powerful source of antioxidants, exhibiting anti-carcinogenic, hepatoprotective, antimicrobial, and anti-inflammatory properties, along with effects that help regulate the immune system [11].

Bioactive Compounds of Beetroot:

Betalains: This review emphasizes the potential of beetroot extract as an anticancer agent. Beetroot is a nutritious plant with a history of medicinal use, offering various health benefits like antioxidant and anti-inflammatory properties. Key bioactive compounds include betalains, flavonoids, and carotenoids, particularly beta-carotene and lutein, known for their anticancer effects. Fermenting beets with lactic acid bacteria enhances their nutritional value and preserves bioactive compounds. Overall, this study highlights beetroot's promise in cancer prevention and its potential for developing natural therapies for cancer patients. This project highlights beetroot extract's potential as an anticancer agent. Beetroot is nutritious and offers health benefits, including antioxidant and anti-inflammatory properties. Its bioactive compounds, such as betalains and carotenoids like beta-carotene, have anticancer effects. Fermentation with lactic acid bacteria enhances its nutritional value. Overall, the study suggests beetroot may play a role in cancer prevention and natural therapies for patients [1, 6].

Flavonoids and Polyphenolic Acids: Phytochemicals are found in plants in significant quantities. Consuming red beetroot is beneficial for health due to its rich content of bioactive compounds, including betalains, flavonoids, phenolic acids, and antioxidants, which are readily absorbed and bioavailable for humans. The impressive antioxidant capacity of beets is attributed not only to the high levels of betalains but also to various phenolic compounds, such as flavonoids and polyphenolic acids. Red beetroot contains notable amounts of catechins and several polyphenolic acids, including ferulic, protocatechuic, vanillic, p-coumaric, p-HBA, syringic, and caffeic acids. However, the composition of plant extracts can vary based on numerous factors, such as the specific plant variety, its maturity at harvest, growing conditions (like climate), and storage practices. Beets stand out with the highest total phenolic content among vegetables. Additionally, red beetroot contains oxalic acid, along with significant amounts of flavonoids, saponins, and triterpenes. Generally, the roots have the lowest phenolic content. Flavonoids, which are abundant in the plant, contribute to the color of beet stems, flowers, and leaves, and are biologically active compounds known for their health-promoting antioxidant properties. It is important to note that the processing of vegetables can lead to a loss of flavonoid content. Therefore, to maximize the health benefits of beetroot, careful evaluation of beetroot formulations containing flavonoids is essential [1, 6].

Carotenoids: Beetroot is rich in carotenoids, which serve as powerful antioxidants and play a crucial role in managing and preventing various health conditions. As photosynthetic accessory pigments, carotenoids help protect vital biological structures, including DNA, from damage caused by free radicals generated during photosynthesis. These compounds belong to the tetraterpenoid class

and are present in smaller quantities within beetroot. The primary carotenoids found in red beets are beta-carotene and lutein, both of which have significant anticancer properties. The levels of these carotenoids vary depending on which part of the plant is examined; the highest concentration is located in the beetroot peel, followed by the pulp, leaves, and stalks. This accumulation occurs primarily in the green parts of the plant, specifically within chloroplasts, where a mixture of alpha and beta-carotene, beta-cryptoxanthin, lutein, zeaxanthin, violaxanthin, and neoxanthin can be found. Notably, alpha-carotene has been identified in both the leaves and tubers of beetroot, with its concentration in the tubers being nearly seven times greater than that in the leaves. Additionally, higher levels of carotenoids are observed in organic stalks and when the plants are cooked, in contrast to those grown through conventional farming methods [1, 6].

Minerals: Beetroot is a rich source of essential natural minerals that support various functions in the human body. Notably, the concentration of copper ions is significantly higher in the leaves, with levels being more than double compared to the tubers. Additionally, minerals like calcium, sodium, potassium, and magnesium are found in greater amounts in the leaves as well. The levels of zinc, phosphorus, and manganese, however, remain relatively consistent across different parts of the plant. Moreover, beetroots and their products are excellent sources of selenium, an important trace element crucial for both humans and animals. Selenium plays a vital role in several metabolic processes, including the metabolism of thyroid hormones and immune system functions. A deficiency in selenium has been associated with various health issues, including cardiovascular diseases, inflammatory conditions, and even cancer. The primary selenium-containing amino acids found in dietary sources are selenomethionine (SeMet) and methyloselenocysteine (MeSeCys), both of which have been identified in beetroot juice. This highlights the nutritional value of beetroot as a functional food that can contribute to overall health [1].

Vitamins: Beetroots and their derivatives are excellent sources of essential vitamins, particularly vitamin C, vitamin A, and various B-group vitamins. The B-group encompasses eight water-soluble vitamins, which include thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), biotin (B7), folate (B9), and cyanocobalamin (B12). The highest levels of ascorbic acid, commonly known as vitamin C, are found in the pulp of the beet, while the leaves contain the lowest amounts. The distribution of vitamin C varies among different parts of the plant, with the order of concentration being pulp > skin > leaf > stalk for organically grown beets, and pulp > stalk > skin > leaf for those grown conventionally. This indicates that the cultivation method can significantly impact the vitamin C content in specific plant parts. Notably, the highest concentrations of vitamin C were observed in all parts of the plants that were fertilized with organic manure. In terms of niacin, the leaves exhibited higher levels of vitamins A, B6, and C, whereas tubers had much greater amounts of folate. Additionally, B-group vitamins were also present in beetroot juices. The findings indicate that organic beet juices are superior sources of vitamins when compared to those derived from conventionally cultivated beets [1].

Other Compounds: Nitrate (NO3) is a crucial inorganic compound found in red beets, and consuming these beets can naturally enhance the production of nitric oxide (NO) in the body. This increase in NO can help prevent various health issues, including hypertension and endothelial dysfunction. Historically, nitrates were viewed negatively due to their potential conversion into harmful nitrosamines, which were linked to endocrinological disorders, fetal defects, and cancer. However, current understanding recognizes that the nitrates in red beets are vital nutrients. Overall, nitrates offer both ergogenic and cardio-protective benefits.

When ingested, the nitrates from beetroots are converted into nitrites and then into nitric oxide, which play significant roles in lowering blood pressure and providing vascular protection. Research has shown that just one week of beetroot juice supplementation can enhance submaximal endurance and lower blood pressure in older individuals with heart failure and preserved ejection fraction. Further studies highlight the positive effects of beetroot supplementation on

physical performance and recovery speed. Additionally, red beetroot can be a valuable component of a healthy diet for those with diabetes. For instance, a study found that consuming raw red beetroot over an eight-week period improved cognitive function, glucose metabolism, and various metabolic markers in patients with type 2 diabetes [1].

CONCLUSION: This review concludes that beetroot extract has considerable potential as an anticancer agent. Commonly known as beetroot, beetroot is a versatile and highly nutritious plant with a rich history of medicinal use and a wide range of health benefits, including antioxidant, antidepressant, antimicrobial, anti- inflammatory and more. The bioactive compounds in beets include betalains, flavonoids, polyphenols, carotenoids and other compounds. Within this carotenoid family, there are two main carotenoids: beta- carotene and lutein, which have strong anti-cancer properties, and betalains and flavonoids also contain anti-cancer properties. Fermentation of beets by lactic acid bacteria not only helps prevent the degradation of the bioactive compounds, but also improves the nutritional value of the products. Overall, this study provides valuable information on the potential use of beetroot in cancer and its use in functional foods and dietary practices. Beetroot extraction aims to find helpful compounds that might prevent cancer. Its rich bioactive composition and safety make it a strong candidate for research into cancer prevention and treatment. Ongoing studies could lead to new natural therapies for cancer patients.

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