A review on Bio-active compounds of beetroot and their function

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Abstract:

Red beetroot (Beta vulgaris) is a root vegetable rich in good nutritional value due to its yielding great qualities in bioactive compounds (nitrates, betalains, and phenolic compounds) which are all essential to support healthy living and avoid diseases. Consumption, mainly in juice form, of beetroot is a relatively inexpensive dietary method for providing beneficial effects on blood pressure, blood glucose levels, vascular function, and kidney function. Beetroot's dietary nitrates convert to nitric oxide in the body, causing blood vessels to dilate, thus increasing blood circulation, reducing blood pressure. Betaine contained in beetroot has antioxidant and anti-inflammatory effects from its high amount of betacyanins and polyphenolic compounds,all of these methods will possibly assist with reducing the levels of oxidative stress and decreasing inflammation in your body (cardiovascular, diabetes, metabolic disorders, and renal problems). Regularly drinking beetroot juice may also help to improve postprandial glucose levels and potentially alter gut microbiota Beet is an agriculturally important plant widely grown for use in sugar production and food colouring. It contains naturally occurring food colorants (betalains) that are also used as a source of food colour and have been shown to have health supporting properties due to several bioactive components found in the plant's various tissues (root, leaf, stems) (e.g., phenolic compounds). As such, beetroot is gaining recognition as a superfood because of the many different biological activities such as antioxidant, anti-inflammatory, cardioprotective, antidiabetic, neuroprotective, and more. Although there are a growing number of studies to support the health benefits of beetroot, additional long-term human clinical studies are necessary to fully quantify its process of action and therapeutic potential.

Keywords:

Beta vulgaris, Dietary nitrates, Betalains, Antioxidant activity, Blood pressure, Blood glucose, Cardiovascular health, Functional food, Gut microbiota

Introduction

It’s no longer just about the basics of nutrition, but the role certain foods can play in providing greater health benefits. They are sometimes said to be functional foods, and beetroot (Beta vulgaris L.) has acquired a great deal of importance among them. Red beet was conventionally consumed as a vegetable in the daily diet, albeit novel studies have brought that it comprises multiple naturally occurring elements that can positively impact human well-being.

Beetroot is particularly appreciated due to its high content of bioactive compounds, which are defined as substances that can modulate biological processes in the human organism. Unlike essential nutrients like protein and carbohydrate, these compounds are needed in much smaller quantities, but

they may exert substantial physiological effects. These are the primarily ones: dietary nitrates, betalains (the pigments that provide the attractive deep red colour), polyphenols, flavonoids and betaine. Each of these ingredients, in its own way, helps contribute to what makes beetroot so good for you.

Bioactive compounds are proteins, carbohydrates and proteins and they are non-essential however, they contribute to health benefits. That powers can be very strong, even sensational"although they are needed in very small amounts. The bioactive compounds that are most researched are betalains, flavonoids, betaine, vitamins and trace minerals These substances found in beetroot each contributes differently to its biological activity.

Among the key properties of beetroot is its very high content of dietary nitrates. These nitrates are converted in the body after ingestion to nitric oxide, a molecule that acts as a vasodilator, relaxing and dilating blood vessels. This leads to better blood flow, contributes to the oxygen supply of the tissues, and has an important function in the regulation of blood pressure. As a result of these properties, the interest in beetroot has increased in both cardiovascular health and sport nutrition.

Beetroot is also special in terms of its betalain content, a group of natural pigments that contribute to the red or purple coloration of beets. These substances are quite uncommon in vegetables and fruits, and they do possess a high antioxidant capacity. Beetroots protect the body from oxidative stress and the body's ability to counteract them. It has also been shown that betalains possess anti-inflammatory effects, which may further add to their protective role in the body. Beetroot holds not only nitrates and betalains but also polyphenols and flavonoids, which are the most researched substances in fruits and vegetables.

From these molecules free radicals can scavenge and cell oxidative damage is reduced. Intake is associated with improved vascular function and it is protected from chronic diseases. There is also the substance betaine (trimethylglycine) in beetroot. Betaine is important in various metabolic pathways, such as liver function and cellular hydration. It also participates in control of homocysteine in the blood. For cardiovascular health, Homocysteine is also considered to be important, as homocysteine levels are high, are linked to cardiovascular disease. Vitamin C and Carotenoids While beetroot also contains vitamin C and carotenoids, these are only present in small amounts, but make a

respectable contribution to the vegetable's antioxidant power. Vitamin C is important for a healthy immune system, wound healing and skin, and carotenoids are well known for their benefits for eye health and protection at the cellular level.

Furthermore, beetroot is widely available and can be easily included in the diet in different forms such as raw slices, cooked preparations, pickles, or juice. However, it is important to note that processing methods such as boiling or long storage can sometimes affect the concentration of certain bioactive compounds.

Bioactive compound and their function

Beetroot is a functional vegetable as it is a good source of several bioactive components that influence human physiology other than that of macronutrients. Such compounds act via multiple biochemical pathways and may contribute to the maintenance of cardiovascular health, antioxidant defence, metabolic regulation, and inflammatory protection. The key bioactive compounds in beetroot are dietary nitrates, betalains, polyphenols, flavonoids, betaine, vitamin C, and carotenoids. Each of these is discussed below in detail.

Dietary Nitrates (NO_3^-) has been highlighted as a key and most thoroughly investigated active component of beetroot. Nitrate is one of the few nutrients that are not biologically active until consumed by the human body. so, consumption a separate path the nitrate–nitrite–nitric oxide pathway is utilized. Bacteria in the mouth reduce nitrate to nitrite, which is ingested and then nitrite is converted to nitric oxide (NO) in the vascular walls and in the stomach and bloodstream. regulation of Blood Pressure, Nitric oxide is a Vaso dilator, which means it relaxes the smooth muscle of the blood vessels. Results in vasodilation which yields arterial dilation, decreased vascular resistance and ultimately to a decrease in blood pressure.

Improvement of Cardiovascular Function and Enhancement of Exercise Performance: Nitric oxide puts less strain on the heart by increasing circulation. It also increases endothelial function, which is crucial for a healthy blood vessel and for the prevention of atherosclerosis.

Betalains they are nitrogenous, water-soluble pigments that impart the red or yellow colours to beets. They are from the following layers: Betacyanins (red-violet pigments) Betaxanthins (yellow-orange pigments) These types of compounds are unique to some extent in natural products and influence biology to a great extent. Strong Antioxidant Activity: Betalains are able to scavenge the reactive oxygen

species (ROS), which are highly reactive unstable molecules that have the ability to attack DNA, proteins and lipids. Oxidative stress, cellular aging and chronic diseases are prevented by the antioxidants. Anti-inflammatory Action: Betalains have been reported to inhibit enzymes involved in pro-inflammatory process, such as cyclooxygenase (COX) and lipoxygenase (LOX)It results in the reduced production of inflammatory mediators in the body, which is useful in arthritis and metabolic diseases .Detoxification Support: Montés et al have proved that betalains are able to stimulate phase II detoxification enzymes in the liver that contribute to get rid of toxic compounds in the body. Potential Anticancer Activity: Betalains may inhibit the growth of cancer cells through apoptosis (programmed cell death) in studies conducted in vitro, but more studies involving humans are required. Polyphenols are a broad class of phytochemicals that are found in the beetroot at levels considered to be moderate.

Cardiovascular Protection, improve endothelial function and reduce LDL oxidation, which is an essential step in the development of cardiovascular disease. blood Sugar Control: Polyphenols inhibit the digestion of carbohydrates and absorption of glucose, which may contribute to maintaining blood sugar homeostasis. Anti-aging Effects, Gut Health Support: Polyphenols are known to have myriad interactions with gut microbiota and stimulate dissemination of good bacteria, which overall results in better digestion. Flavonoids are a type of polyphenol, which are also found in beetroot, but in much lesser quantities than in fruit and leafy vegetables. Functions of Flavonoids Antioxidant Defence: Flavonoids stabilize free radicals, by virtue of donating electrons that neutralize them, that without being stable radicals may cause oxidative stress. Anti-inflammatory Properties: Flavonoids also modulate the inflammatory pathways including NF-κB and thereby reducing chronic inflammation. Immune System Support: They promote immunity by influencing immune cells and by mitigating oxidative stress in immune organs. Betaine (Trimethylglycine) an active substance in beetroot, it is the source of many metabolic and cellular processes. Uses of Betaine Liver Function and Fat Metabolism: Betaine assists in the prevention of fat buildup in the liver by promoting fat metabolism. It has a role in fatty liver prevention. Osmoregulation: Betaine also contributes to osmoregulation in individual cells, assisting them in the retention of water and shielding them against the effects of drying out and/or salty environments. Methylation Reactions: Also

known to be involved in methylation, a chemical process necessary to repair DNA, regulate gene expression, and functions of protein.

Vitamin C (L-Ascorbic Acid) Beetroot has some amounts of the important water-soluble vitamin. Vitamin C aids the production and function of white blood cells so that it provides help in fighting infection. It is also necessary for collagen production, which keeps skin, bone, and connective tissue firm. Antioxidant Protection Vitamin C scavenges free radicals and regenerates other antioxidants within the cell. Carotenoid are fat soluble pigments found in tiny concentrations in beetroot. Roles of Carotenoids. Protection for the Eye: Carotenoids also protect the retina from oxidative stress and could be associated with a lower risk of age-related eye diseases. skin Protection Carotenoids guard against UV-mediated skin photodamage and improve skin appearance, Carotenoids in the support of immune function through maintenance of immune cell membrane integrity and promotion of cell–cell communication "Immune cells contain significantly greater quantities of carotenoids than other cells of the body, and appear to utilize carotenoids much like they do for vitamin A by cleaving them.

Conclusion

Beetroot is a busy little taproot, yet it is rarely given a second thought in our everyday meals, although science has confirmed it harbours an astonishing array of health-promoting substances. What makes it so powerful is not a single active compound, but rather a mixture of several bioactive compounds that act synergistically in the human body. Dietary nitrates, betalains, polyphenols, flavonoids, betaine, vitamins and carotenoids contribute in several ways to general well-being. So together these compounds are, if not unique, certainly uncommon. Some of them, including dietary nitrates, are focused on the cardiovascular system and increase blood flow and lower blood pressure. Others, such as betalains and polyphenols, have strong antioxidant effects that protect the cells of the body against damage from stress and pollution. compounds including betaine that support liver function and metabolic homeostasis, and vitamins and carotenoids that boost immunity, skin health and overall cellular defence.

What's particularly fascinating, is that none of these substances lend themselves to being effectual alone. They do so by synergistically interacting within the human body for instance, antioxidants that shield blood vessels from harm also aid in the promoting of blood flow resulting from

nitrates. This type of natural synergy is why beetroots are considered a functional food rather than just a vegetable. Furthermore, from a convenience perspective, it's also pretty easy to add beetroot into your daily diet. You can eat it as a juice, salad, have cooked vegetable or even in the form of powder. Nevertheless, the profits are most significant when taken regularly rather than all at once. In summary, beetroot is an inexpensive and natural source of bioactive compounds with the potential to favourably modulate the uptake of signals associated with maintaining good health and with protection from disease. Although it's not a treatment for any disease, eating it regularly may help promote heart health, reduce oxidative stress, strengthen metabolism and improve overall well-being. As studies progress, it is anticipated that beetroot will continue to be recognized as a key functional food in both nutrition research and in daily dietary use.

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