

Importance of Beetroot Juice as a Compulsory Dietary Food

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Abstract – Dietary supplementation with beetroot juice (BR) containing ~5-8 mmol of inorganic nitrate (NO₃⁻) increases plasma nitrite concentration ([NO₂⁻]), reduces blood pressure, and may positively influence the physiological responses to exercise. However, the dose-response relationship between the volume of BR ingested and the physiological effects invoked has not been investigated. In a balanced crossover design, 10 healthy males ingested 70, 140 or 280 ml of concentrated BR (containing 4.2, 8.4 and 16.8 mmol NO₃⁻, respectively) or no supplement to establish the effects of BR on resting plasma [NO₃⁻] and [NO₂⁻] over 24 h. Subsequently, on six separate occasions, 10 subjects completed moderate-intensity and severe-intensity cycle exercise tests 2.5 h post-ingestion of 70, 140 and 280 ml BR, or NO₃⁻-depleted BR as placebo (PL). In a randomized open design, 100 male healthy volunteers aged between 12-30 years are assigned to consume the 250 ml of Beetroot juice for three consecutive days up to 9 weeks period. Present study demonstrate that dietary NO₃⁻, administered in the form of beetroot juice (250 ml/day for 9 weeks), decreases systolic blood pressure (SBP). These results may provide a mechanism by which nitrate exerts beneficial effects on muscle function with applications to sports performance and a potential therapeutic role in conditions with muscle weakness.

Keywords: Importance, Beetroot Juice, Compulsory, Dietary Food, Muscle, Weakness, Potential Therapeutic, Beneficial, Nitrate, etc.

INTRODUCTION

Beetroot (*Beta vulgaris* L.) is crop belonging to the Chenopodiaceae family having, bright crimson colour. It is famous for its juice value and medicinal properties; and known by several common names like beet, chard, spinach beet. Sea beet. Garden beet, white beet and Chukander (in Hindi). Beetroot gives the best value from June to November, and for storing, the beetroot leaves should be cut 50 mm above the root. They will keep for 4-5 days when refrigerated in the vegetable crisper. Beetroot 'Boltardy' is one of the best varieties which produce large round shaped tender roots of deep red colour and fresh sweet flavour. Beetroot 'Burpees Golden' is globe shaped and golden orange in color. It is biennials if roots are grown for seed. It was not cultivated until the 3rd century and not developed until the 19th century by German and French breeders. Beetroot is the name used by the British and some other English speaking countries including Australia and the New Zealand for the vegetable that Americans in the USA call beets a type of food. Beetroots main benefits are that it contains no fat, very few calories and is a great source of fiber. The best quality and root color are obtained when the air temperature ranges between 10 and 18 °C. Abundant

rainfall, nitrogen fertilizer and high temperatures provide for rapid development which leads to white rings in the interior of the beetroot. The minimum soil temperature for beet germination is 5 °C, with an optimum range of 10 to 30 °C, an optimum temperature of 30 °C and a maximum temperature of 35 °C. Beets require a cold period of 2 weeks at 4 to 10 °C or longer to initiate flowers. Beets will tolerate frosts and mild freezes. Beets prefer deep, friable, well drained, sandy loams to silt loams. High organic matter in the soil is desirable and will help ensure an adequate moisture supply. The beet has a fairly large root system extending downward in the soil 1 m or more unless restricted (Compendium of Beet Diseases and Insects).

Beets are used for bunched greens, bunched roots, and beetroots and by processors for many products. Beetroots for processing and fresh markets are harvested mainly in September and October. A yield of 20,000 kg per hectare is possible. The roots and greens therefore are great for women in general and for those planning pregnancy. The fresh beetroot and sliced beetroot are shown in figure 1.



Figure 1: (a) and (b) shows fresh and sliced beetroot respectively

REVIEW OF LITERATURE:

Beetroot is a good tonic food for health. The main markets for beet greens and bunched beets are roadside, farmers markets and deliveries to wholesalers. The market for beetroot is not a large market but it is significant. With storage the marketing season may be extended for roots. *Beta vulgaris* var. *rubra* revealed significant tumor inhibitory effects in skin and lung cancer. These findings suggest that beetroot ingestion can be a useful means to prevent development and progression of cancer. But extracts of beetroot also showed some antimicrobial activity on *Staphylococcus aureus* and on *Escherichia coli* and also antiviral effect was observed (Rauha et al., 2000). Today the beetroot is still championed as a universal panacea. One of the most controversial examples is the official position of the South African health minister on the treatment of AIDS. Dr Manto Tshabalala-Msimang, health minister under Thabo Mbeki, had been nicknamed "Dr Beetroot" for promoting beets and other vegetables over antiretroviral AIDS medicines, which she considers toxic (Blandy, 2006). Beetroot is one of the original 'super foods'. Beetroot is a naturally environmentally-friendly crop, rarely needing treatment with pesticides. Up to 10 per cent of beetroot is sugar, but it is released slowly into the body rather than the sudden rush that results from eating chocolate.

The usually deep-red roots of beetroot are eaten boiled either as a cooked vegetable, or cold as a salad after cooking and adding oil and vinegar, or raw and shredded, either alone or combined with any salad vegetable. A large proportion of the commercial production is processed into boiled and sterilized beets or into pickles. In Eastern Europe beet soup, such as cold borscht, is a popular dish. Yellow-coloured beetroots are grown on a very small scale for home consumption (Grubben et. al., 2004).

Effects of a commercially available beetroot juice on inflammation is strongly involved in the development and progression of several clinical conditions including coronary heart disease and cancer, beneficial effect of beetroot extract may relate to this anti-inflammatory capacity.

Hughes and Mitchell (2006) reported that both shallow and deep beds of diced beetroot have been studied,

variables investigated being D.B.T. 120-200 °F (49–93 °C); air flow (6-12 lb of air/sq. ft /min); W.B.D. 10-70 °F (-12 to 21 °C). Drying rates in shallow beds were found to depend largely on the D.B.T., the W.B.D. and air-flow rate having a less marked effect. A prediction method used to determine the drying times of deep beds of diced beetroot in the moisture content range 8 to 0.1 was applied and found to be accurate to $\pm M 9.0$ %. Moisture distribution in a single slice of beetroot during drying has also been studied. Pickled beets are a traditional food of the American South. It is also common in Australia and New Zealand for pickled beetroot to be consumed on a burger. Garden beet juice is a popular health food betanins, obtained from the roots, are used industrially as red food colourants e.g. to improve the colour of tomato paste, sauces, desserts, jams and jellies, ice cream, sweets and cereals. Red beet also makes a rich, red, Burgundy style wine. The wild sea beet is the earliest form of beetroot and is supposed to be the source for all the different beetroot varieties available today. The vegetable was native to the Indian and British coastlines. The beetroot, as we know it today, was only developed in the sixteenth century. Roots can be round shaped, cylindrical or tapered. Their colour can be white, yellow or red according to the colour of the flesh. The leafy tops can also be used as a tasty spinach substitute. Beetroot juice contains a high level of biologically accessible antioxidants (Wootton-Beard, Moran, & Ryan, 2011) as well as many other health promoting compounds such as potassium, magnesium, folic acid, iron, zinc, calcium, phosphorus, sodium, niacin, biotin, B6 and soluble fibre. Additionally, drinking beetroot juice provides a more convenient alternative to consuming the whole vegetable. The specific interest in beetroot juice has arisen because it is a rich source of a number of polyphenolic compounds.

A further study by this research group isolated a number of other compounds in four beetroot cultivars using high-performance liquid chromatography-electrospray ionization-mass spectrometry (HPLC-ESI-MS); Table 1 shows the predominant betalain and phenolic constituents. Betanins was shown to be the most abundant betalain in the flesh and peel of each cultivar whilst 5,50,6,60-tetrahydroxy-3,30-biindolyl, feruloylglucose and b-d-fructofuranosyl-a-d-(6-O-(E)-feruloylglucopyranoside) were all present in higher quantities in the peel compared to the flesh. Vulgaxanthin I and II were the predominant betaxanthins. There are also other varieties of beetroot where the ratio of betacyanins to betaxanthins changes which is reflected in the colour of the root. Betanin, together with its aglycone betanidin have been independently shown to have high antioxidant activity. Beetroot also contains smaller amounts of other compounds, such as carotenoids and ascorbic acid which may further increase its total antioxidant capacity.

Convenience is considered a considerable marketing tool in the food industry and conscientious food manufacturers are looking for ways to make healthy food, particularly fruit and vegetables, more convenient to consume in order that public health may be improved. There has been a significant increase in the number of fruit based beverages which are available in UK commercial outlets over the past decade and they have become an important method of fruit intake, particularly for children.

Classification	Compound
Betalains	
Betaxanthins	Vulgaxanthin I Vulgaxanthin II
Betacyanins	Betanin Isobetanin
Phenolics	
Ferulic acid conjugates	5,5',6,6'-tetrahydroxy-3,3'-biindolyl Feruloylglucose β -d-fructofuranosyl- α -d-(6-O-(E)- feruloylglucopyranoside)
Phenolic amides	N-trans-Feruloyltyramine N-trans-Feruloylhomovanillylamine
Flavonoids	Betagarin Betavulgarin Cochliophilin A Dihydroisorhamnetin

Table 1 – Reported phytochemical composition of red beetroot

Origin of beetroot - The ancient Babylonians was the first to use it for various applications. Early Greeks and Romans used the root for its medicinal properties and the leaves as vegetables. Moving ahead with time, beetroot held an important place in medicine. In England, beetroot juice or broth was recommended as an easily digested food for the aged, weak, or infirm. Even in mythology, Aphrodite is said to have eaten beets to retain her beauty. In folk magic, if a woman and man eat from the same beet, they will fall in love. In Africa, beets are used as an antidote to cyanide poisoning. Nutritional value of fresh beetroots per 100 g are given below -

Constituents	Amount	Constituents	Amount
Carbohydrates	9.96 g	Vitamin B ₆	0.067 mg
Sugars	7.96 g	Folate (Vit. B ₉)	80 µg
Dietary fiber	2.0 g	Vitamin C	3.6 mg
Fat	0.18 g	Calcium	16 mg
Protein	1.68 g	Iron	0.79 mg
Vitamin A equiv.	2 µg	Magnesium	23 mg
Thiamine (Vit. B ₁)	0.031 mg	Phosphorus	38 mg
Riboflavin (Vit. B ₂)	0.027 mg	Potassium	305 mg
Niacin (Vit. B ₃)	0.331 mg	Zinc	0.35 mg
Pantothenic acid (B ₅)	0.145 mg	Sodium	77 mg

Table 2: Nutritional value of fresh beetroots per 100 g

Effect of Beetroot Juice on Moderate-Intensity Exercise: Dietary nitrate (NO₃⁻) supplementation,

particularly in the form of beetroot juice, has become popular in light of recent studies documenting its ergogenic effects on exercise economy/efficiency and endurance performance. The effects of nitrate supplementation are believed to be the result of increased nitric oxide (NO) bioavailability following a series of reductions (NO₃⁻ NO₂⁻ NO) in the entero-salivary and peripheral circulatory systems. While the vasodilatory effects of NO are well known, NO's ability to acutely reduce muscle ATP utilization and mitochondrial oxygen consumption are remarkable because they challenge the tenet that the metabolic cost of steady-state exercise at a fixed work rate is largely invariant. Such a rapid and fundamental change in exercise metabolism may have an impact on daily training and implications for exercise prescription. In this study, we used an RPE clamp model to determine the effects of acute dietary nitrate supplementation - in the form of beetroot juice – on self-regulated exercise performance using a double-blind, placebo-controlled, crossover design.

Inorganic Nitrate and Beetroot Juice Supplementation Reduces Blood Pressure:

Hypertension exceeds smoking as a causal factor in total attributable mortality. Globally, two-thirds of stroke and one-half of ischemic heart disease events are linked to non-optimal blood pressure (BP)4 control, which contributes to ~13% of all deaths and 4.5% of all disability-adjusted life years. Antihypertensive drugs have attenuated the adverse effects of BP on cardiovascular health, but an adequate and sustained control of BP is achieved in only; 50% of hypertensive cases. Therefore, nutritional and lifestyle-based interventions are unanimously recognized as important strategies for the primary prevention of hypertension and as adjuvants in pharmacological therapies to reduce cardiovascular risk. The Dietary Approach to Stop Hypertension (DASH) is one of the most effective nutritional interventions for the prevention and no pharmacological management of hypertension. The diet highlights the importance of an increased fruit and vegetable intake and recent research has suggested that the beneficial effects of the DASH diet on BP are related to the high inorganic nitrate content of some of the food products included in the DASH dietary plan (e.g., green leafy and root vegetables). Larsen et al. tested for the first time in a double-blind crossover study the effects of sodium nitrate on BP in healthy volunteers and reported a significant reduction in diastolic BP (23.7 mm Hg). Beetroot is particularly rich in inorganic nitrate content (typically ranging from 110 to 3670 mg nitrate_kg) and it has therefore been utilized in several studies as a nutritional strategy to test the effects of inorganic nitrate intake on BP. For example, Webb et al. showed in healthy participants that 24 h after a single dose of 500 mL beetroot juice, systolic and diastolic

BP were reduced by 10.4 and 8.0 mm Hg, respectively.

Beetroot Juice Supplementation Reduces Whole Body Oxygen Consumption:

Nitric oxide (NO) is an important signalling molecule; it has been implicated in the regulation of many biological processes, including blood flow, skeletal muscle excitation–contraction coupling and mitochondrial bioenergetics (Boushel *et al.* 2012). While NO was originally thought to be exclusively generated from nitric oxide synthase-mediated oxidation of L-arginine, it is now acknowledged that NO can also be generated from the sequential reduction of nitrate (NO_3^-) and nitrite (NO_2^-) in a process dependent on bacterial nitrate reductases produced by facultative anaerobes in the oral cavity (Govoni *et al.* 2008). Given the diverse biological effects of NO, the oral consumption of NO_3^- has been investigated as a modality to alter metabolic responses to exercise. Indeed, amongst dietary supplements, nitrate is unique in that it decreases the oxygen cost of submaximal exercise in humans. While the mechanism(s) of action remain unresolved, one prominent working model is an improvement in mitochondrial coupling efficiency. This possibility is supported by the *in vitro* observations that NO directly increases oxidative phosphorylation efficiency (Clerc *et al.* 2007), particularly when cytochrome oxidase is reduced. In addition, dietary supplementation with sodium nitrate for 3 days in humans improves various parameters within isolated mitochondria, including assessments of efficiency (P/O ratios and thermodynamic coupling). Altogether, sodium nitrate consumption and NO appear to have the capacity to improve mitochondrial bioenergetics through alterations in coupling efficiency. Several vegetables have high NO_3^- concentrations, creating the potential for a natural food product to exert similar beneficial effects to sodium nitrate. To date, beetroot juice (BRJ) has been shown to reduce blood pressure, oxygen consumption during exercise, and improve exercise performance, vascular control, and muscle contractile function in humans (Haider & Folland, 2014). Indirect assessments of muscle metabolism via P-magnetic resonance spectroscopy suggest that BRJ consumption reduces ATP turnover during muscle contraction, which probably contributes to the observed attenuation in oxygen consumption during exercise. It remains to be determined if BRJ, similar to sodium NO_3^- , improves mitochondrial oxidative phosphorylation efficiency to further explain the observed reduction in whole body oxygen consumption.

CONCLUSION:

This paper concludes the all scope of beetroot and their utilization. It emphasis the medicinal, nutritional importance of the beetroot for the consumption of human being. Individuals with a history of oxalate-containing kidney stones should limit their consumption

of beets. As beetroot juice is very potent, do not consume too much, especially if your body is not yet accustomed to it. For a beginner, start with the juice of half a medium-sized beetroot once a week, slowly increasing to one whole beetroot a week. A harmless side effect of drinking beetroot juice is that your urine may turn pink or red. Given the potential for the multiple health benefits of polyphenol consumption, beverages containing high levels can be considered a positive addition to the diet. Additionally, both sensory characteristics and convenience would appear to be important factors in obtaining an increased level of consumption amongst the general public. Beetroot juice provides a significant source of dietary polyphenols and in particular, a shot can provide a significant quantity of these bioactive components together with a convenient method for consumption. The beetroot juice contributes to improve the Haemoglobin in the blood. The cost of the beetroot is low when comparing with other iron rich vegetables and it can be stored easily. So the researcher took the present study to show the effectiveness of beet root juice on improving Haemoglobin level among the adolescent girls in selected school, Chennai. The researcher had her own limitation such as faced difficulty in seeking permission in selected school and could not control other foods rich in iron. The investigator recommending following points can be carried out in the future as All the adolescent girls who are anemic can take the beetroot juice for 20 days to improve their hemoglobin level, similar study can be replicated in different settings, study can be combined with other available local resources (e.g. Plantain stem) and comparative study can be conducted between the beet root juice and beetroot juice with vitamin c rich food (lime).

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