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Study of effect of beetroot juice in muscle damage recovery during anaerobic exercise with reference to Unani system of medicine

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Abstract
The purpose of this review is to evaluate the effect of beetroot juice in muscle damage recovery during anaerobic exercise in unani medicine because unani medicine claims that beetroot juice is Muhalil-e-waram and the term Muhalil-e-waram means to reduce the inflammation and to reduce the swelling. And according to modern science, beetroot juice is antioxidant and anti- inflammatory food because it has a high NO_3^- content. NO_3^- can be reduced to nitrite via bacteria in oral cavity and by special enzymes (Ex-Xanthine oxide) within tissues.
There are several pathways to metabolize nitrite to Nitric oxide (NO) and other biological active nitrogen oxide. NO is signaling molecule formed in the endothelium by the enzyme endothelium NO synthase which triggers the vasculature to relax (vasodilatation) by interacting with vascular smooth muscle leading to increase blood flow. NO facilitates increased blood flow at rest and during exercise and hence it reduces inflammation and helps in improving muscle damage recovery in short time duration.

Keywords: Beetroot, Muscle damage, Anaerobic exercise, Inflammation, Nitric oxide (NO), Unani medicine, Muhalil-e-waram

Introduction

Beetroot (*Beta vulgaris*)

Beetroot is a vegetable (root) like turnip [1, 2, 4]. It is white inside and out. Its leaves are like spinach leaves. Its taste is sweet like carrot. This is Muhalil-e-waram. To cure the waram (any swelling, wound, inflammation) apply the water of its leaves.
It is of two types.

1. Large and broad leaves of dark red color.
2. It is pink in color and soft and broad leaves without fibers [1, 3].

Beet root is Muhalil-e-waram [1, 2, 3]. The term Muhalil-e-waram is used to reduce any abnormal swelling which is due to accumulation of blood, pus, water and flatus, may be considered as a term nearest to inflammation and inflammation may be considered as a type of warm [5, 10, 6]. So beetroot is an anti-inflammatory medicine and it is used to reduce inflammation and improve muscle damage recovery during anaerobic exercise.
In Unani medicine, inflammation has not been described as has been in conventional medicine. However, a term waram (swelling) mentioned in Unani medicine referring to any abnormal swelling, be it due to accumulation of blood, pus, water and flatus, may be considered as a term nearest to inflammation to some extent especially when it is har (acute). But waram, a general term including all types of abnormal swellings, should not be exactly correlated with modern concept of inflammation; instead, inflammation may be considered as a type of waram [5, 6]. In Unani medicine, management of waram varies according to the nature and presence of matter e.g., hot, cold, hard etc. It also depends on organs in which swelling has occurred. Unani Medicine claims many single and compound drugs for reducing inflammation and pain. Many single as well as compound drugs are in use as Muhalil-e-waram(anti-inflammatory) as well as musakkin (analgesic) [5, 7, 8].
Beetroot (*Beta vulgaris* L.) contains high amounts of biologically active substances including betalains, carotenoids, phenols, B-vitamins (B1, B2, B3, B6 and B12), folate

minerals, fibers, as well as sugars with low energetical value [9], and inorganic nitrate [10]. All parts of this plant have different medicinal uses, such as antioxidant, anti-depressant, anti-microbial, anti-fungal, anti-inflammatory, diuretic, expectorant and carminative [11], hepato-protective [12], or protector of cardiovascular health. Other benefits reported by [10, 13] include the inhibition of lipid peroxidation and chemo-preventative effects [14, 15, 18].

Green leaves and stems are a perfect solution in obesity problems and weight management, as they are typically low in calories. The high level of vitamin A, K and C is important to produce a protein essential for bone health. Green leafy vegetables are a major source of iron and calcium for any diet. Leafy vegetables are used in preventing chronic diseases, such as cancer, cardiovascular disease and diabetes, as they have anti-inflammatory and anti-carcinogenic activity. Beetroot leaves are used to reduce blood pressure [16, 17, 18].

The color of beetroot stems from its purple and yellow pigments (betacyanin and betaxanthin, respectively), known collectively as betalains. These betalains have potential antioxidant-capacities [19, 20, 29].

Beetroot juice (BRJ) has marketed on the internet to support digestive and blood health, improve energy, be a natural cleanser and increase levels of nitric oxide (NO) leading to increased blood flow. In addition, BRJ has been indicated to possess anticancer properties, can lower the risk of coronary events (stroke and peripheral vascular disease), lower blood pressure and reduce inflammation [21]. These claims have boosted the popularity of BRJ. Several of the properties of BRJ mentioned above have been hypothesized to enhance athletic performance. For example, betaine has been shown to favorably enhance performance outcomes. [22] However, the additive or synergistic effects of the constituents contained within BRJ have not been extensively studied. Nevertheless, both anecdotal and scholarly evidence supports the use of BRJ to produce faster finish times [23, 24] increase time to exhaustion, [25-27] reduce steady state oxygen (O2) consumption [25, 26] increase peak power [25, 28] and increase work rate at the gas exchange threshold**.** Therefore**,** this review will examine the impact specifically of BRJ, rather than each constituent, on athletic performance [29].

Beetroot is grown for food uses (pickles, salad, juice) rather than for sugar production. In contrast to other fruits, the main sugar in beetroot is sucrose with only small amounts of glucose and fructose [30]. Because fructose reduces human exercise capacity, a low fructose and a high sucrose content is preferable, for example, in sports drinks [31, 32].

Exercise-induced muscle damage

Exercise-induced muscle damage (EIMD) is defined as a set of potentially deleterious symptoms that develop in the hours and days following exercise [33, 34]. Common symptoms include reduced force generating capacity, increased muscle soreness, swelling, and a reduced range of motion [35, 36, 33]. These symptoms can be evoked by resistance training [37], prolonged running and cycling [38, 39], intermittent, high-intensity exercise [40] and eccentric exercise [41], and can last for several days, depending on age, sex, training status, and genetic [36, 33].

While the etiology of EIMD is not completely understood, the current consensus is that it stems from physical damage to myofibrils and disruption of excitation-contraction coupling [33]. Subsequently, these perturbations evoke proteolysis and inflammation that can exacerbate the initial injury and delay recovery [42, 35, 33]. Strategies to attenuate EIMD typically attempt to mitigate the inflammatory response and/or oxidative stress (defined as a state where the production of reactive oxygen species (ROS) outweighs their clearance and macromolecule damage ensues) [43, 35, 34]. In this regard, numerous interventions have been administered including cold water immersion, compression garments, non-steroidal-anti-inflammatory drugs, and nutritional supplements with anti-inflammatory or antioxidant effects (e.g., vitamins C and E or (poly)phenols) [35, 34] Such interventions may be beneficial in situations where rapid recovery is essential, such as during multi-day events (e.g., fixture congestion in team-sports, stage races, heptathlon/decathlon, or competitions comprising heats, semifinals, and finals) [52].

Supplementation with nitrate, a precursor for the multifunctional signaling molecule nitric oxide (NO) and other reactive nitrogen intermediates, has been shown to reduce inflammation [44, 45, 46] oxidative stress [47, 48] and stimulate muscle-resident satellite cells [49]. In addition, nitrate is most often administered in the form of beetroot juice, which also contains various bioactive compounds known to have antioxidant and anti-inflammatory effects, such as betalains and (poly)phenols [48, 50, 51]. Such effects suggest nitrate or nitrate rich vegetable supplements with other bioactive compounds like beetroot juice, hold promise as recovery aids following EIMD [48, 52].

Beetroot, NO_3^-, and NO

Beetroot has a high NO_3^- content (250 mg/100 g of fresh weight), among the highest assessed, and other foods high in NO_3^-include spinach, celery, lettuce, and carrot juice [73]. NO_3^-can be reduced to nitrite via bacteria in the oral cavity and by specific enzymes (e.g., xanthine oxidase) within tissues. There are several pathways to metabolize nitrite to NO and other biologically active nitrogen oxides [54]. NO is a signaling molecule formed in the endothelium by the enzyme endothelium NO synthase, which triggers the vasculature to relax (vasodilatation) by interacting with vascular smooth muscle leading to increased blood flow [55, 56]. NO facilitates increased blood flow at rest [57] and during exercise [58]. Given these properties, NO has gained a lot of attention for possible exercise improvements including increased O_2, glucose, and other nutrient uptake to better fuel working muscles [59, 60]. Reported NO production contributed significantly to exercise-induced skeletal muscle glucose uptake, independent of skeletal muscle blood flow. Currently there is no means to provide NO supplementation through the diet, as it is a gas, thus BRJ and its high NO_3^- concentration is used to generate NO endogenously. In fact, up until this point, much of the support for NO use to improve exercise performance has relied heavily on "borrowed science" using amino acids such as L-arginine [61]. Much more impressive is the growing body of scientific data in support of whole food sources of inorganic NO_3^-, such as that found in BRJ, and improved athletic performance [29].

Mechanisms of action for Beetroot juice (BRJ)

Several mechanisms have been postulated for the various exercise improvement effects of BRJ.A reduction in phosphocreatine (PCr) degradation and the reduction of build-up of adenosine diphosphate (ADP) and inorganic

phosphate at the same relative exercise intensity following BRJ consumption [25, 28] are likely mechanisms responsible for the decrease in O_2 cost (oxidative phosphorylation) of exercise and increased time to exercise failure (reduced muscle fatigue). Indeed, NO may lessen fatigue at the same exercise intensity due to a slowing of cross-bridge cycling kinetics by reducing calcium (Ca^{2+}) sensitivity by decreasing the number of cross bridges in the force generating state [62] or by inhibiting the mechanical properties and adenosine tri-phosphatase activity of myofibrils [63]. NO also modulates ryanodine receptor (Ca^{2+} release channels) activity by S-nitrosylation or oxidation of several classes of cysteine residues associated with the protein, thereby affecting Ca^{2+} release [64] and inhibiting Ca^{2+}-adenosine tri-phosphatase activity [65]. Consequently, these data suggest that BRJ may have a regulatory influence on the ATP cost of force production [27, 54] reported that muscle mitochondria extracted after NO_3^- supplementation indicated an improvement in oxidative phosphorylation efficiency (P/O ratio) and a decrease in state [20] respiration (basal respiration associated with maintenance costs). The improved mitochondrial P/O ratio correlated with a reduction in O^2 cost at rest and during exercise. These authors [54] and others [23, 66] indicate that NO_3^- reduces the expression of ATP/ADP translocase, an enzyme involved in proton conductance [54]. ATP/ADP translocase is a transporter protein that facilitates the mobilization of ATP and ADP into and out of the inner mitochondrial membrane for ATP use [67]. Several proposed mechanisms for BRJ to enhance PCr/ muscle recovery during hypoxia, such as that experienced during high-intensity exercise scenarios, include increased efficiency of mitochondria and increased delivery and perfusion of O^2 to working muscles [68]. Whether overall cellular metabolism is enhanced is yet to be determined. It is possible that gene expression regulation, mitochondrial biogenesis, immunomodulation, and cell cycle/apoptosis control also account for the ergogenic effects of BRJ [24, 69-71, 29]

Antioxidant benefits

While improvements in performance of both aerobic and anaerobic exercise are reported via numerous proposed mechanisms, the impact of BRJ serving as a potent dietary antioxidant must be explored. As such, the antioxidant capabilities of BRJ and its constituents could further enhance the ability to sustain exercise, or possibly, aid in recovery from exercise. Intense exercise, especially to exhaustion, has been shown to increase free radical concentrations in the muscles and liver by two to three times [72]. Interestingly, several recent investigations have examined the potential antiradical properties of certain constituents of BRJ, namely betacyanin's and betaxanthins, the main pigments of red beetroots [19]. In addition [20] reported that linoleate peroxidation by cytochrome c was inhibited by betanin from red beets. It was suggested that regular beetroot consumption may provide protection against certain oxidative stress-related disorders in humans [20] and therefore may serve as a useful strategy to enhance recovery from exercise and subsequent exercise performance [29].

Discussion

The aim of the current study is that whether beetroot juice is highly effective or not effective in muscle damage recovery and improve exercise performance.

According to unani medicine, Chief function of beet root is Muhalil-e-warm and in unani medicine Muhalil-e-waram means to reduce the any abnormal swelling which is due to accumulation of blood, pus, water and flatus and these conditions may be considered as a term nearest to inflammation and in unani system inflammation is a type of waram hence beetroot juice is anti-inflammatory medicine and it reduce the inflammation and recover the muscle damage and increase vasodilation, muscle contraction and improve exercise performance and to enhance the recovery of the muscle functioning because according to modern science, beetroot has a high NO_3^- content and NO_3^- can be reduced to nitrite via bacteria in the oral cavity and by special enzymes (Ex- xanthine oxide) within tissue. There are several pathways to metabolize nitrite to nitrous oxide and other biologically active nitrogen oxide.

NO is a signaling molecule formed in the endothelium NO synthase which triggers the vascular smooth muscle leading to increase blood flow. NO facilitates increased blood flow at rest and during exercise.

NO has gained a lot of attention for possible exercise improvements including increases O_2 glucose and other nutrient uptake to better fuel working muscle. NO production contributing significantly to exercise induced skeletal muscle glucose uptake, independent of skeletal muscle bold flow.

Currently there is no mean to provide NO supplementation through the diet as it is a gas thus beetroot juice and its high NO_3^- concentration is used as a means to generate NO endogenously. In fact up until this point much of support for NO use to improve exercise performance has relied heavenly on borrowed science using amino acids such as L-arginine. It much more impressive is the growing body of scientific data in support of whole food source of inorganic NO_3^- such as that found in BRJ and improved athletic performance. Hence according to unani medicine it is conclude that beetroot juice is effective in muscle damage recovery and improve the exercise performance in short time duration.

Conclusion

In summary, this review indicated that beetroot juice is highly effective in muscle damage recovery and exercise performance. Beetroot juice supplementation might serve to protect against the negative effects of exercise induced muscular damage which might be of particular benefit to individuals required to perform several bouts of potentially damaging exercise in a short time duration.

Beetroot juice has been shown to improve the release and reuptake of calcium at the sarcoplasmic reticulum. This could help the power production associated with improvements in muscle shortening velocity and are sensitive to such improvements in power generation.

Conflict of interest

None

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