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Effect of Carrot-Beet Based Beverages to Modulate Hypertension

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Abstract

The objective of this study was to assess the effect of carrot and beetroot-based beverages to modulate hypertension in hypertensive subjects. Two different combinations of carrot-beetroot juice were prepared consisting of Beverage-I (carrot juice 20% and beetroot juice 80%) and Beverage-II (carrot juice 40% and beetroot juice 60%). Antihypertensive influence of beverages was assessed through physiological markers i.e., pulse rate, body temperature, systolic and diastolic blood pressure. Serum lipid profile including triglycerides, cholesterol, high density lipoprotein and low-density lipoprotein was also assessed at start and termination of the experimental trial. Results obtained at the end of the study revealed that Beverage-I influentially reduced the pulse rate, systolic and diastolic pressure, triglycerides, and LDL levels however, in case of total cholesterol, a more pronounced effect was observed in subjects receiving Beverage II. From the outcomes, it was concluded that both beverages showed modulation of hypertension and hence, these beverages can be considered for routine dietary therapy to address hypertension.

Keywords: Antioxidant, Carrot-beet Beverages, Hypertension, Lipid Profile, Dietary Nitrates

1. Introduction

Food is the elementary need of individuals for their survival, growth, and maintenance. According to health experts, dieticians and nutritionists, a healthy diet is now an important issue for all individuals. A healthy diet has more impact on the prevention and treatment of a number of diseases (Engelhard, Gazer, & Paran, 2006; Kim et al., 2011). In developing countries, metabolic disorders consequent to inadequate intake of micronutrients and unhealthy food consumption are the major concerns of this era (Iahtisham-Ul-Haq & Butt, 2015). To elaborate the importance of various food components in disease prevention and cure, the term "functional food" has been established. Functional foods are natural or industrially processed foods when regularly consumed as part of a diverse diet, provide health-boosting effects beyond basic nutritional needs (Granato et al., 2020). The foods that are derived from plants are often rich in phytonutrients and play a significant role in disease control alongside health maintenance. The popularity of functional foods has

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increased among consumers because of increased awareness about the importance of healthy diet in sustaining healthy living. Regular consumption of fruits and vegetables is associated with low incidence of lifestyle related degenerative ailments (Engelhard et al., 2006; Kim et al., 2011). Studies have revealed that the chronic diseases like diabetes, obesity, hypertension and chronic heart disease can be prevented by the regular intake of fruit, vegetables, and dietary fibers (Iahtisham-Ul-Haq et al., 2020).

Hypertension is a common, insidious and deadly disease often diagnosed incidentally at normal screening or routine clinical visit (Alexander, Ostfeld, Allen, & Williams, 2017). Globally, 31.1% of adults (1.39 billion individuals) are suffering from hypertension resulting in 9.4 million deaths annually (Gedamu & Sisay, 2021). In developing countries this burden is raising drastically because a number of hypertensive people remain undiagnosed, inadequately managed or untreated leading to increased burden of cardiovascular diseases (Undavalli & Mp, 2018). Although medications are available to treat hypertension, several studies have shown that lifestyle modifications *i.e.* physical activity, smoking avoidance and healthy dietary habits can help in preventing and/or treating hypertension (Duman, 2013). Increased intake of foods from plant sources rich in sterols, polyphenols and flavonoids have been found to be associated with lower risk of hypertension and cardiovascular diseases (Alexander et al., 2017; Duman, 2013). Therapeutic diets can sufficiently lower the cholesterol in plasma (Imran et al., 2020). Oxidative stress and inflammation have been observed as the major factors associated with initiation and progression of hypertension and linked anomalies (Pouvreau, Dayre, Butkowski, De Jong, & Jelinek, 2018). In this context, the natural antioxidants derived from plants have been studied for their oxidative stress mediated malfunction against free radical scavenging potential (Kujawska et al., 2009). Moreover, the harms of aging process and allied problems may be prevented by the consumption of natural antioxidant rich diet (Ravichandran et al., 2013; Vulić et al., 2014).

Carrot (*Daucus carota*) belongs to the family "Umbelliferae". Carrots are popular in Asian and western region of the world. The bioactive component abundantly found in carrots is known as "Beta-carotene" which is an orange-red pigment with sufficient nutraceutical potential. Moreover, carrots are also considered as rich source of fiber (Buijsse, Feskens, Kwape, Kok, & Kromhout, 2008). Besides, Alpha-carotene and Lutein present in carrots acts as potent antioxidant (Griep, Verschuren, Kromhout, Ocké, & Geleijnse, 2011). Vitamins, sugar, and minerals are very important for a healthy living and fresh plant-based beverages contain plenty of vitamins and nutrients. It has been proven that *Daucus Carota* extract enriched diet reduced the low-density lipoprotein, plasma triglycerides level, hypertension, and total dietary fat. The extract also showed substantial hypolipidemic activity and obstructs the production of free radicals (Singh & Hathan, 2014).

Red beetroot (*Beta vulgaris* L.) belonging to family "Chenopodiaceae" has number of variations and show yellow to red hue (Iahtisham-Ul-Haq, Butt, Randhawa, & Shahid, 2019a; Singh & Hathan, 2014). The active components in red beetroot are betalains with high biological value. Betalains are nitrogenous compounds capable of delivering protective effects against different diseases (Iahtisham-Ul-Haq, Butt, Randhawa, & Shahid, 2019b). There are further two subgroups of betalains: the red/purple betacyanins which are associated with the shade of red beetroot and yellow/orange betaxanthins that relates to the color of yellow beetroot (Iahtisham-Ul-Haq, Butt, Randhawa, & Shahid, 2020). It has been demonstrated that consumption of dietary nitrate could play a vital role in preventing cardiovascular disease and hypertension in

healthy individual (Bondonno et al., 2015). Higher concentration of inorganic nitrate is available in red beetroot, typically ranging between 110 to 3670 mg nitrate kg^{-1} that may positively alleviate hypertension (Siervo, Lara, Ogbonmwan, & Mathers, 2013). It has been proven that nitrate ingestion in the form of nitrate salt or in vegetable product form like beetroot juice could be helpful in reducing blood pressure greatly as well as beetroot juice also have nitrate supplement which appeared as a potential nutritive agent to prevent and cure of hypertension and coronary artery diseases (Wylie et al., 2013).

The primary objective of this research was to explore the antihypertensive effect of carrot and beetroot juice in combination. Hence, carrot and beetroot are employed in the current study for development of carrot-beetroot based beverages and their bio-evaluation to modulate hypertension.

2. Materials and Methods

2.1 Development of Beverages

Garden-fresh red beetroot and carrots were obtained based on uniformity in color, size, and absence of any physical damage. Both vegetables were washed to remove any adhered material from their surfaces. After that, they were peeled off and cut into small sized dices. Red beetroot juice and carrot juice was obtained using a home-scale juicer. Two beverages with different proportions of carrot and beetroot juices were prepared and the final products were kept in refrigerator at temperature (4-6℃). These proportions were obtained based on sensorial acceptability of the beverages. The beverage containing 20% carrot juice and 80% beetroot juice was regarded as Beverage-I whilst the beverage containing 40% carrot juice and 60% beetroot juice was regarded as Beverage-II.

2.2 Experimental Design

To assess the therapeutic potential of carrot-beetroot based beverages, hypertensive patients were enrolled in a clinical experimental trial after taking their consent. The study was approved after meeting all the ethical standards by the "bioethics committee" of the University of Agriculture, Faisalabad after institutional screening. After taking prior written consent, 24 hypertensive subjects of age between 23-45 years were randomly divided into 3 experimental groups having 8 patients in each group and were prescribed a controlled diet plan to follow during the trial. The subjects in group G1 were provided 250 mL of Beverage-I whilst subjects in group G2 were given 250 mL of Beverage-II on alternative days in the morning for 60 days whereas G0 served as control.

2.3 Biological Assessment

The body temperature was checked *via* a thermometer and blood pressure was recorded by using digital sphygmomanometer. To test the effect of beverages on lipid profiles, blood samples were evaluated at initiation and termination of the trial for triglycerides, total cholesterol, high- and low-density lipoproteins using commercial kits (Ecoline™ Merck KGaA) (Imran et al., 2018).

2.4 Statistical Analysis

All the data collected were statistically analyzed using Statistix 8.1 statistical software (Tallahassee, Florida, USA). The Microsoft Excel v2016 was used for handling data and graphs preparation. Two-way ANOVA was used for checking statistical significance established at $P<0.05$. Tukey's Honest Significant Difference test was used for post-hoc comparison of means.

3. Results

The results showed that carrot-beet-based beverages significantly ($P<0.05$) affected the pulse rate of hypertensive patients. Figure 1 illustrates that Beverage I had reduced pulse rate of participants in G1 (64.38±4.17) more influentially up to 23% than Beverage II in G2 (76.25±5.18) which reduced the pulse rate up to 9% when compared with untreated patients of G0 (83.75±5.18) group. Whilst, in the case of body temperature, statistical analysis revealed no significant differences amongst the groups.

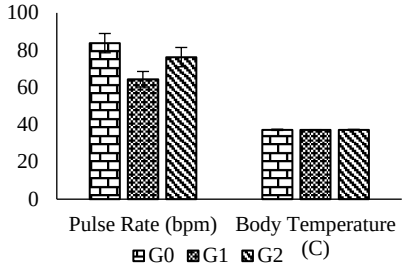

Figure 1 Effect of carrot-beet beverages on pulse rate and body temperature of hypertensive subjects [G0:control group, G1:group provided with 20% carrot juice and 80% beetroot juice as Beverage-I, G2: group provided with 40% carrot juice and 60% beetroot juice as Beverage-II]

Fig. 2 shows the average systolic and diastolic blood pressures of hypertensive patients. The statistical analysis depicted significant ($P<0.05$) variation in the average systolic as well as diastolic blood pressure of individuals enrolled in different groups. According to results obtained, treatment with Beverage I and Beverage II reduced systolic pressure in G1 and G2 up to 8.65 and 7.61%, respectively with trial progression as evident from the trend deduced from initial to final readings. Furthermore, in case of final values obtained at termination of experiment, G1 and G2 had lower systolic pressure as 118.75±6.41 and 121.25±8.35, respectively in comparison to G0 (130±9.26). For diastolic blood pressure, a reduction of 6.02 and 4.47% was recorded in Beverage I and Beverage II treated groups *i.e.,* G1 (78.75±8.35) and G2 (80±5.35), respectively than G0 (83.75±7.44).

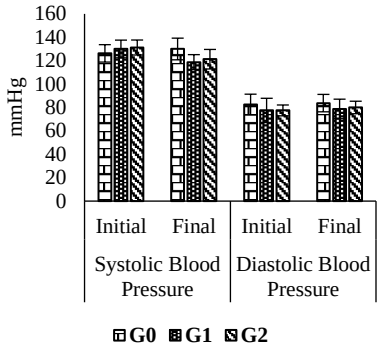

Figure 2 Effect of carrot-beet beverages on systolic and diastolic blood pressures [G0: control group, G1: group provided with 20% carrot juice and 80% beetroot juice as Beverage-I, G2: group provided with 40% carrot juice and 60% beetroot juice as Beverage-II]

The lipid profile of the hypertensive patients (Fig. 3) revealed that Beverage I and Beverage II caused significant ($P<0.05$) decline in cholesterol (A), triglycerides (B) and LDL (D) while increase in HDL (C) in G1 and G2, respectively than G0. Fig. 3 shows that at the end of experimental period, reduction in cholesterol, triglycerides and LDL was recorded in G1 up to 9.90, 10.44 and 14.22% while in G2 up to 13.62, 4.68 and 8.86%, respectively when compared to initial values. Contrary to this, an increase in HDL was observed by 11.29 and 7.40% in G1 and G2, respectively. Overall, carrot-beet based beverages significantly

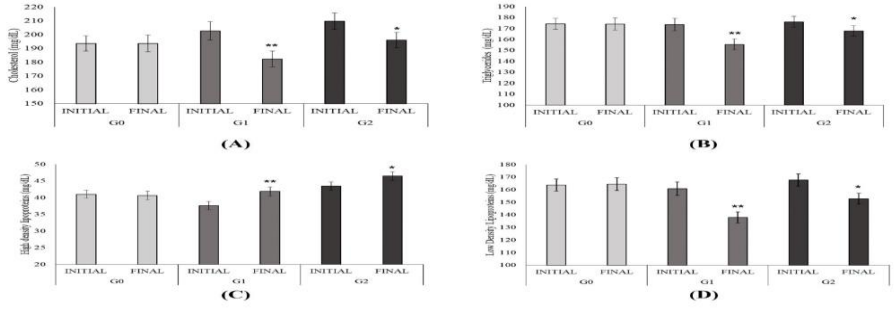

Figure 3 Effect of carrot-beet beverages on lipid profile of hypertensive subjects [G0: control group, G1: group provided with 20% carrot juice and 80% beetroot juice as Beverage-I, G2: group provided with 40% carrot juice and 60% beetroot juice as Beverage-II]

controlled the physiological markers related to hypertension.

4. Discussion

It is widely known that different foods are rich sources of various health promoting bioactive components, vitamins and minerals that support human health and bodily functions. Evidence is rising that higher consumption of functional foods lessens the chance of morbidity and mortality associated to lifestyle related disorders particularly cardiovascular disorders and hypertension. In this context, different combinations of carrot and beetroot beverages were examined for their antihypertensive effect in current experiment. Treatment with the beverages lowered pulse rate in hypertensive patients than the non-treated subjects. A possible reason behind could be the dilation of blood vessels in response to nitrates found in beetroots. Several previous studies have reported that beetroot juice does not influence the pulse rate significantly but a decreasing trend has been observed in people treated with beetroot juice than the placebo (Bender et al., 2018; Ormesher et al., 2018; Velmurugan et al., 2016). The significant decline in pulse rate recorded in current study might have occured due to combined effect of beetroot juice with carrot juice. Carrot juice is rich in potassium which is an important component of body fluids and helps in maintaining the heart rate (Aderinola & Abaire, 2019). Increased intake of potassium slows the rate of pacemaker depolarization during heartbeat and thus slows down the heart rate (Aziz, Li, & Tinker, 2018).

Regarding systolic and diastolic blood pressure, both beverages have shown the blood pressure reducing effect. The results are in line with those reported by Ormesher *et al.* (Ormesher et al.) who evaluated the hypotensive effects of nitrates from beetroot juice in hypertensive pregnant women. They found that beetroot juice significantly reduced the systolic blood pressure by 7% than baseline values after 24 hours of supplementation while for diastolic pressure they observed non-significant difference in baseline and after supplementation values. The dietary nitrates from beetroot juice are rapidly absorbed in saliva from blood *via* active transport which are then converted into nitrites by oral microflora (Kapil et al., 2013). These nitrites have been proven for their blood pressure-lowering effect in both hypertensive (Webb et al., 2008) and normotensive subjects (Ghosh et al., 2013). The other major component of the treatment beverages, carrot juice is full of antioxidants, phenolic acids and flavonoids and it has been reported that carrot juice reduces the oxidative stress that plays a key role in progression and pathogenesis of hypertension (Baradaran, Nasri, & Rafieian-Kopaei, 2014; da Silva Dias, 2014). A group of peers has recently explored the hypotensive potential of carrots and reported that carrot supplementation completely prevented the increase in systolic and diastolic blood pressure consequent to high fat diet consumption in mice (Soleti et al., 2021). They proposed that carrots showed the blood pressure lowering effect not only by reducing the reactive oxygen species but also increased the availability and production of nitric oxide which triggers the hypotensive influence (Craig et al., 2020).

Our results revealed that both beverages significantly reduced the total cholesterol, LDL, and triglyceride levels in hypertensive patients. These results agree with the findings of Asgary et al. (2016) who investigated hypolipidemic effects of raw beetroot juice and cooked beet on hypertensive patients and concluded that raw beetroot juice showed more prominent effect in lowering total cholesterol (10.5%), LDL (12%) and triglycerides (13.54%) than cooked beet. Current outcomes are in line with Rahimi et al. (2019) who reported that supplementation of red beetroot to atherosclerotic patients decreased the level of total cholesterol, triglycerides and LDL by 7, 6 and 12%, respectively in comparison to placebo

treatment. Besides, beetroot juice also increased the HDL content up to 4.42%. Furthermore, Holy and coworkers also observed reduction in serum levels of LDL, total cholesterol and triglycerides after beetroot juice supplementation to healthy objects however, they reported non-significant effect of beetroot juice on HDL concentration (NNIaBON, 2017).

Regarding the hypolipidemic effects of carrot juice these findings are supported by the outcomes of Żary-Sikorska, Fotschki, Fotschki, Wiczkowski, and Juśkiewicz (2019) who explored the impact of carrot-based preparations on lipid profile and antioxidant status of rats and observed that carrot preparations significantly decreased the triglycerides and total cholesterol in blood. They proposed the mechanism behind that could be the bioactive components especially anthocyanins in carrots affected the production of short chain fatty acids from gut microbiota and hence improves serum lipid profile.

Carotenoids are known to inhibit lipid peroxidation in arterial walls, influencing plaque stability, vasomotor function, platelet aggregation, and thrombosis (Asplund, 2002). Human studies suggest that elevated plasma β-carotene is associated with reductions in circulating cholesterol and the risk of myocardial infarction. Carotenoids in beetroot juice are cleaved by the 2 enzymes namely ß-carotene Oxygenase 1 (BCO1) and ß-carotene Oxygenase 2 (BCO2). Amongst them BCO1 is the only enzyme which is involved in production of vitamin A from provitamin A carotenoids (Amengual et al., 2013; Coronel, Pinos, & Amengual, 2019). Amengual et al. (2020) later explored that it is the activation of BCO1 enzyme, in response to carotenoids in carrot juice, which reduces the total cholesterol concentration in serum instead of ß-carotenes.

5. Conclusions

The research indicates the positive role of carrot and beetroot juice in controlling hypertension. The provision of carrot and red beetroot juice radically improved the lipid profile, pulse rate and systolic and diastolic blood pressure. Therefore, the consumption of carrot and beetroot juice may be beneficial for the maintenance of good cardiac health. Our results suggest the anti-hypertensive effect of nitrate-containing carrot and beetroot juice, but this study is conducted only by considering hypertensive patients. It is recommended that carrot and beetroot-based beverages should be incorporated as part of routine diet and used as nutritional therapy for hypertensive individuals. However, further research on synergistic or antagonistic effects of such beverages with other food components may be investigated for more personalized dietary regimens and nutrition therapies.

6. Conflict of Interest

The authors declare no coflict of interest.

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