Versatile Nutraceutical Potentials of Watermelon

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Watermelon (Citrulus lantus) is an important horticultural crop which belongs to the Curcubitaceae family. The nutraceutical potential of watermelon has been illustrated by several researchers, which makes it a better choice of functional food. Watermelon has been used to treat various ailments, such as cardio-vascular diseases, aging related ailments, obesity, diabetes, ulcers, and various types of cancers. The medicinal properties of watermelon are attributed by the presence of important phytochemicals with pharmaceutical values such as lycopene, citrulline, and other polyphenolic compounds. Watermelon acts as vital source of l-citrulline, a neutral-alpha amino acid which is the precursor of l-arginine, an essential amino acid necessary for protein synthesis. Supplementation of l-citrulline and lycopene displayed numerous health benefits in in vitro and in vivo studies. Similarly, the dietary intake of watermelon has proven benefits as functional food in humans for weight management.

functional food | l-citrulline | lycopene | obesity | polyphenols

1. Introduction

Consumption of fruits and vegetables in regular diet provides several health benefits. The wide occurrence of phytochemicals such as carotenoids, lycopenes, anthocyanins, phenols, and flavonoids along with vitamins and minerals makes the choice of plant based diet healthier. It lowers the risks of various dreadful diseases such as cancer, cardiovascular diseases, neurodegenerative disorders and aging associated ailments. Plants, being the wide source of pharmaceutically valuable secondary metabolites, provide diverse products in the form of fruits and vegetables loaded with nutraceutical potential. In general, the major role of secondary metabolites in plants are pertained to the protection against diverse abiotic and biotic stresses. In addition, secondary metabolites also acts as an antimicrobial agents and antioxidants to combat stresses.

Watermelon is a notable horticultural crop belonging to the Cucurbitaceae family cultivated widely for its delicious fruits. Asian countries contribute approximately 81% of total production of watermelon worldwide [1]. According to the Food and Agricultural Organization of the United Nations, a cultivation area of 3.2 million hectares was employed for the production of 103 million tons of watermelon worldwide in 2018 [1]. The watermelon fruits are used for the preparation of smoothies, jams, sauces, candies, and juices. Watermelon serves as a vital natural source of l-citrulline (0.9 to 5 mg/kg of fresh fruit) [2]. The refreshing taste, high water content, and its attractive colors ranging from red, yellow, and pink increases the consumption of watermelon. The diverse colors of watermelon are due to the presence of carotenoids especially, lycopene and β-carotene [2]. The sweet taste of watermelon is contributed by the combination of sugars such as glucose, sucrose, and fructose. Moreover,

watermelon, acts as a vital reservoir of valuable phytochemicals with high nutrition and pharmaceutical potentials. In particular, watermelon can be considered as an excellent functional food due to its rich lycopene, vitamin A, vitamin C contents and antioxidant potentials [3][4]. Bioactive compounds present in watermelon render numerous health benefits, such as decreasing the risk of cardio-vascular disease, aging related ailments, obesity, diabetes, and various cancer alleviating effects have been reported [5][6][7][8][9][10]. In 1930, Wada [11] determined and isolated citrulline, a non-essential amino acid from watermelon which is involved in the synthesis of arginine. The amino acid arginine is vital for the endogenous synthesis of nitric oxide, a crucial signaling molecule involved in various neurological and immune responses in animals and humans [12]. Watermelon acts as a vital dietary supplement to enhance the arginine content. In watermelon, citrulline aid in the tolerance against stresses such as drought [13]. Moreover, the seeds of watermelon are enriched with protein, fat, and moderate levels of iron and zinc. Watermelon seeds are consumed as snacks, fat binder, soup thickener, condiments, and also for the extraction of cooking oil [14][15][16]. The occurrence of high arginine content in the seeds of watermelon adds its medicinal benefits [17]. Due to the presence of various nutritious benefits the seeds of watermelon possess application in the field of several food products. Recently, Sola et al. [18] identified and quantified the phytochemicals in the methanol extracts derived from the seeds of watermelon. Furthermore, the report [18] evidenced the anti-bacterial property of watermelon seed extracts.

2. Cardiovascular Protection by Watermelon

Cardiovascular diseases are the leading cause of increasing death rate worldwide. Moreover, the cost of treating cardiovascular disease are high. Therefore, adapting a lifestyle with cardio-friendly diet would decrease the risk factors associated with the disease. Fruits and vegetables can combat the negative effects of cardiovascular diseases. l-citrulline and l-arginine possess the capacity to alleviate the inflammation and oxidative stress [19][20]. However, direct intake of l-citrulline and l-arginine could lead to gastro-intestinal discomforts such as nausea and diarrhea [21][22]. Therefore, the consumption of fruits rich in l-citrulline (precursor of l-arginine, an essential amino acid for protein synthesis)—such as watermelon—is important to obtaining the necessary nutrition. Supplementation of whole watermelon in powder form improved the lipid profiles, antioxidant status, and anti-inflammatory properties of high fat fed rats [23]. Moreover, the ingestion of watermelon regulated the expression of genes associated with lipid metabolism [23]. In detail, the augmentation of watermelon and l-arginine enhanced the regulation of hepatic gene expression of endothelial nitric oxide synthase. Nitric oxide (NO) is a ubiquitous signaling molecule vital for the relaxation of blood vessels and it also reduces the atherosclerosis by influencing the lipid metabolism [23][24][25]. On the other hand, watermelon supplementation down-regulated the genes involved in lipid metabolism such as fatty acid synthase (FAS), 3-hydroxy-3methyl glutaryl-coA reductase (HMGCR), sterol regulatory element binding protein (SERB) 1, SERB 2, cyclooxygenase-2 (COX2), and nuclear factor-kB (NF-κB) in rats [23]. Among the above enzymes, FAS plays an important role in the denovo synthesis of fatty acids, whereas HMGCR acts as a rate limiting enzyme in cholesterol synthesis [26]. Similarly, both SREBP-1 and SREBP-2 regulate the transcription of genes involved in fatty acid and cholesterol synthesis respectively [27].

Oxidative stress and inflammation are the key players in the onset of atherosclerosis. The serum C-reactive protein levels are utilized as the indicators of systemic inflammation which leads to cardiac dysfunction [28][29]. Watermelon intake significantly reduced the levels of C-reactive protein levels in the serum of high fat fed rats [30]. Moreover, watermelon also down-regulated the expression of Cox-2 enzyme responsible for the synthesis of pro-inflammatory prostaglandins. Furthermore, Hong et al. [30], illustrated that the watermelon supplementation exhibited similar mechanism to non-steroidal anti-inflammatory drugs that inhibits the activity of Cox-2 and reduces the inflammatory response. A recent study has demonstrated the ability of watermelon to reduce the risk factors of cardiovascular disorder in human [31][32]. According to Connolly et al. [32], consumption of watermelon in daily basis for a period of four weeks resulted in significant reductions in body weight, body mass index, waist-to-hip ratio, and blood pressure. In addition, the report also claims that the watermelon supplementation lowered the levels of triglyceride, low density lipoprotein cholesterol, thiobarbituic acid reactive substance, and increased the antioxidant capacity in obese adults [32]. Overall, it has been evident that the consumption of watermelon in regular basis reduces the risk factors associated with chronic illnesses such as cardiovascular diseases.

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