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Natural Purplism of Fruits and Lifestyle Disorders: An Overview.

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ABSTRACT

Increasing anecdotal reports on the effects of antioxidant phytochemical compounds have established the pharmacological evidences for curing several life style diseases and disorders in humans. Fruits and vegetables are rich source of health promoting compounds such as vitamins (vitamin C, folate, and provitamin A), phytochemicals (flavonoids, phenolic acids, alkaloids, and carotenoids), and fibres. Natural fruit colour particularly purple, blue, and/black due to the presence of different anthocyanins not only give attraction but enriched nutritional benefits as well. Epidemiological studies have consistently shown that high intake of anthocyanin-linked compounds is negatively associated with reduced risk of major chronic diseases. This mini review summarizes the results of anthocyanin-based investigations and emphasizes the aspects that warrant future research to explore the anthocyanins' bioactivities against different human diseases.

Keywords: Anthocyanin, fruits, life style disorders, antioxidant activity, bioactive molecule

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INTRODUCTION

Oxidation is the process that takes place throughout the metabolic activity in the body. Our cells utilize oxygen and produce free radicals as by products and these free radicals get clinked to our tissues and damage all cellular macromolecules as proteins, carbohydrates, lipids and nucleic acid resulting in age induced oxidative stress, consequently our immune system gets weakened [1] and become vulnerable to autoimmune and lifestyle disorders in the form of cardiovascular diseases, cancer, hypertension, obesity, diabetes etc [2-3]. Other environmental factors as exposure to smoking, ultra-violet light, pollution and radiation trigger the formation of free radicals inside the body. The situation gets worse when our diet is scarce in antioxidants as the resistance to fight with free radicals gets weakened. Antioxidants are the substances that engulf these free radicals and prevent us from the oxidative damage. The source of antioxidants is endogenous and exogenous as well. Our body has antioxidative enzymes in the form of superoxide dismutase, glutathione peroxidise, catalase etc. However, dietary antioxidants boost the immune system and give strength to endogenous enzymes as with ageing the endogenous sources do not get replenished without dietary sources. Plant products in the form of coloured fruits and vegetables are an immense source of these compounds.

Anthocyanins are the flavonoid pigments fall under phytochemical compounds that are present in red and purple coloured fruits as pomegranates, raspberries, blueberries, bilberries, cherries, cranberry, chokeberry, strawberries, purple grapes, blackcurrants, beets etc. Anthocyanin is one of the subclass of flavonoids, which is further classified as flavonones, flavan-3-ols, flavonoid polymers, flavonols and flavones. There are certain plant groups that fall under these categories as tea extracts fall under flavan-3-ols, citrus fruits (oranges, lime, tangerines) under flavonones, wines, cocoa under flavonols, celery under flavones, grape seeds as flavonoid polymers and the berries, pears, apples as anthocyanins

Figure 1: Principal anthocyanin content in different fruits

Cyanidin	Delphinidin	Pelargonidin	Malvdin	Peonidin	Petunidin
• Blackcurrants • Raspberries • Elderberries • Red cabbage	• Blackcurrants • Blueberries	•Strawberries • Radishes	•Grape	•Craneberries	•Blueberries

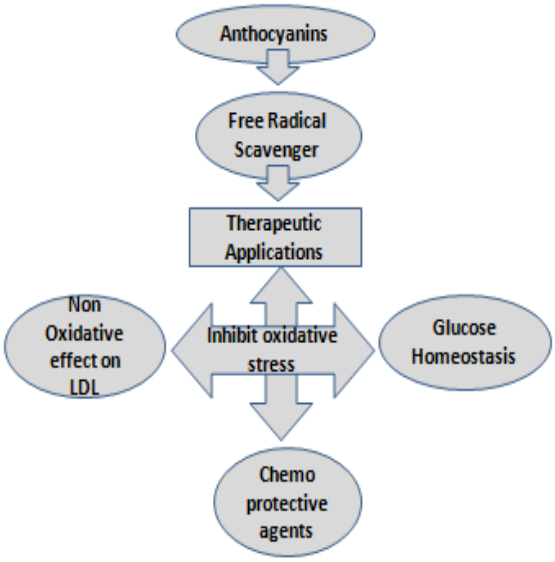
Varieties of antioxidative compounds are found in the fruits. Anthocyanins present in berries as cyaniding-3-sambubioside, cynadine-3-glucoside, cynadine-3-xylosylrutinoside, cynadine-3-rutinoside, and pelargonidin rutinoside. Color of these fruits is due to the pigments, which are also called as flavonoids [4]. They enhance the flavour and provide us with the eminent antioxidants. The wide vitamin that is present in citrus fruits as ascorbic acid is the powerful antioxidant and renders protection against many diseases. Other pigments that present are anthocyanins, lycopene, xanthonin etc. These compounds are polyphenolic in nature with high or low molecular weight. Several studies have confirmed the role of these compounds (Q10, coenzyme, polyphenols etc.) in the prevention of clinical

diseases. The free radicals are unstable in nature and in order to get stabilized they attack cellular tissues and rendered them unstable, resulting in the inhibition of growth of normal cells and leads to proliferation of cells that generate antibodies against the activity of their own [5].

Miraculous Role of Anthocyanins on Lifestyle Disorders for Human Sustenance

Natural fruit colour particularly purple, blue, and/black due to the presence of different anthocyanins not only give attraction but enriched nutritional benefits as well. Epidemiological studies have consistently shown that high intake of anthocyanin-linked compounds is negatively associated with reduced risk of major chronic diseases (Fig. 2).

Figure 2: Different functions of Anthocyanins



Anthocyanins and cardiovascular disorder

Eating a rich diet in fruits and vegetables, known to cut down the risk of developing cardiovascular disease. This is due to the fact that addition of oxygen leads to oxidation of low density lipoprotein (LDL) which contributes to deposition of plaques on the arterial cell wall, resulting in blocking the pathway of blood flow and finally in cardiac myofarction [6]. However, the initial process of oxidation and pace of plaque deposition is inhibited by the action of antioxidants as the free unstable electrons of the free radicals are engulfed by the antioxidants.

Antioxidants are categorised under hydrophilic and hydrophobic. They are synthesized in our body itself and can be acquired from dietary sources as well. Vitamin C, glutathione, lipoic acid and uric acid are come under water-soluble antioxidants while alpha tocopherol, carotene, ubiquinol are lipid soluble antioxidants. It is far better to get the antioxidants from the natural sources in the form of colored fruits not from the artificial supplements [7].Eating a diet rich in fruits is linked to reduce the potential risk for

developing cardiovascular diseases. These benefits are likely to get from eating them directly instead of taking artificial products. Relationship has been found between hypertension and anthocyanins as hypertensive patients are prone to CVD's than non-hypertensive patients [8]. The vasodilatory properties of anthocyanins are found to be responsible in combating hypertension in vitro studies. 8% reduction in hypertension is found in patients who were predominantly given strawberries and blueberries.

The link of anthocyanins in giving protection against CVD's is the retarding action towards the oxidative stress that is the primary cause for developing the vascular diseases. It has been found that purple grapes have attenuated the various risk factors responsible for developing of CVD [9]. As routinely, process of utilizing oxygen by the cells and tissues and release of free radicals cannot be inhibited but free radicals can be engulfed with action of antioxidants along with the consumption of these phytochemical compounds [10]. Antioxidant activity of the anthocyanins is due to their polyphenolic structure.

Anthocyanins and Cancer

A protective relationship has also been observed in risk of cancer and consumption of antioxidants from fruits. Various studies indicated the role of berries as potent inhibitors for cancer growth. Compounds present in the raspberries particularly as anthocyanins prevented the growth of cancerous cells in oesophagus found in study on rats [11]. Several studies have confirmed the role of anthocyanins in prevention against leukaemia, colon cancer, liver cancer, skin cancer, breast cancer [12-13]. These prevention properties are based on the scavenging activity of phytochemicals towards reactive oxygen species (ROS) along with the apoptosis of the malignant cells [14-16].

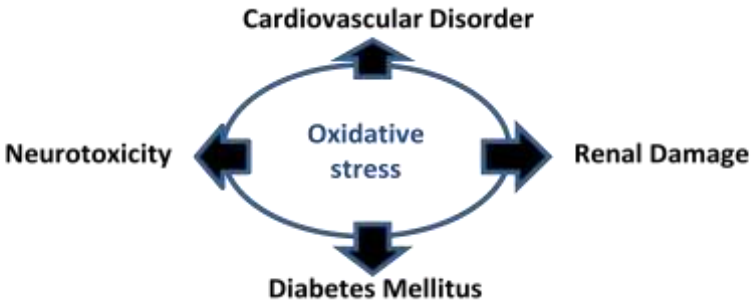
There is a need to see the role of anthocyanins in chemotherapy as this cause severe harm to both cancerous and normal cells. The regenerative or protective effect of anthocyanins needs to be investigated. Continuous exposure to the free radicals causes mutations in the differentiation of normal cells, resulting in the growth of cancerous cell in later years. Exposure of free radicals can only be camouflaged through the consumption of regular anthocyanins in the form of coloured fruits. The studies on the correlation of the amount to be consumed and their effect on the cell surface is one of the important aspects that need to be uncovered. As once it gets certained, quantification effect of the antioxidant activity on malignant cells would get simpler. A pilot study has summarised the oral role of anthocyanins on the colorectal cancer. It was found that 0.5gm of bilberry anthocyanins may play an effective role as chemo preventive agents [17].

Chemo preventive action of bilberry and chokeberry extracts are observed to be inhibitor of cells of colon cancer. These berries contain anthocyanins on cyanidin derivatives. This structure composition plays an essential role in inhibitory action on the growth of oncocells [18]. Relationship between structural roles of anthocyanins on the inhibitory action has been observed. Nonacylated monoglycosylated are found with significant inhibitory action on proliferation of cells of colon cancer [19].

Anthocyanins and Oxidative Stress

Oxidative stress is a common mechanism leading to multiple disorders in form of CVD's, diabetes, neurodegenerative disorders, genetic mutations and renal ailments [20]. The production of metabolic bi-products as free radicals is responsible for developing oxidative stress as uptake of oxygen by cellular fatty tissues leads to lipid per-oxidation resulting in oxidative damage.

Figure 3: Health problems owing to oxidative stress



Numerous studies have been reported on the effect of extracts of fruits and vegetables on preventing the oxidative damage to cellular organelles. Anthocyanins from the red cabbage have been found in reducing the oxidative damage in rats. The effect has been observed on decreasing the catalytic activity of liver mitochondrial action [21].

Tart cherry juice has been found in improving the antioxidative defences in vivo in older adults and has decreased the damage to nucleic acids [22]. Study on red wines has found that oxidative damage on renal tissues may be reduced on consumption of their moderate amount. It is related to the fact that red wines are the sources of polyphenols and anthocyanins are the major compounds rendering dark color to wines. Study supported the fact as moderation consumption of wines has a protective role on cardiovascular diseases, similarly, renal tissues can be safeguarded [21]. This can be related to other side as well, that intake of anthocyanins through berries can have significant impact on the renal damage and major complication of uncontrolled type 2 diabetes i.e nephropathy, which spreads as glomerular damage, acute and chronic renal failure can be prevented or delayed.

Oxidative stress has a major contribution towards neurodegeneration causing Alzheimer's disorder [23]. Continuous generation of reactive oxygen species causes protein oxidation, neuronal cell death, DNA oxidation [24]. No antioxidative compounds control this molecular pathogenesis; however, dietary antioxidants belonging to polyphenolic nature can be outlines for slowing the progression of neurodisorder [25-26]. Phenolic compounds from the extract of blackcurrants found to be protected against neurotoxicity and DNA damage and have significantly inhibited the reactive oxygen species along with act as a scavenger for $H_2O_2^-$ free radicals and proved as a good candidate to be used as a nutraceuticals in edible products [27]. Berries are good source of antioxidant activity due to the potent source of anthocyanins and have been emerged as a good scavenger for human health. The multiple biomedical functions have opened its broad spectrum for human

sustenance as age induced oxidative stress fostering various inflammatory diseases, pathogenesis to nucleic acids, CVD's and neurotoxicity [28].

Anthocyanins and Diabetes

Since the last decade, diabetics have grown in tremendous number and this is likely to increase by 200 million by 2030 [29]. This has attributed majorly to the lifestyle adopted, changes in the eating pattern, and involvement in sedentary activity. Adopted lifestyle in terms of eating pattern and physical activity has created metabolic changes in the body. The consumption of fibre, vitamins and bioactive compounds (phytochemicals as flavonoids) through fruits, vegetables, native herbs has been reduced drastically. As a result, production of free radicals makes the physiological system more resistant to fight with the endocrinological disease. Consumption of refined carbohydrates induces abdominal obesity and increases the waist-hip ratio, which is the predominant factor in development of diabetes. Recently, the link has been found between insulin sensitivity in diabetes mellitus and intake of anthocyanins [30]. It has been reported that the potential risk of developing type 2 diabetes can be reduced by consuming more than 2 servings of anthocyanins. However, particular flavonoid has not been indicated and has non-significant relation with total flavonoid consumption.

β- Cells of islets of langerhans play a major role in controlling type-2 diabetes disorder. Loss of β- Cells sensitivity is one of the major endogenous causes for diabetes. A study has been done (31) in order to locate the relationship between association of dietary flavonoids and impairment of pancreatic β- Cells due to progressive oxidative stress. However, borderline significant association has been found. This may be due to the fact that flavonoids from the tea, pears and apples were taken for consideration. They may have less potency in relation to the anthocyanins present in berries. Progressing of oxidative process is the major factor for developing type 2 diabetes and after development; it further gets advanced and come in the way of diabetic complications as nephropathy, neuropathy, retinopathy, risk of myocardial infarction etc [32]. The pace of these complications is further hastened due to the consumption of synthetic food products having artificial colorants, flavouring compounds, texture modifiers etc [33]. As a result, intake of natural products in the form of bioactive compounds (flavonoids, antioxidants) is reduced tremendously.

Pathways of lifestyle disorders end up in common destination i.e. type 2 diabetes. These are obesity, hypertension, and oxidative stress due to hyperglycemia and hyperlipidemia as they play clinical role in developing insulin resistance [34]. Consequently, the mode of acquiring these disorders is the inclusion of faulty foods of just empty calories and no functional value at all. Functional foods are those, which are not consumed for their calorific value, rather for their bioactive role in the form of antioxidants, flavonoids as anthocyanins and other phytochemical compounds [35].

The role of phytochemicals as anthocyanins is likely to affect the glucose homeostasis in turn reducing the development of metabolic syndrome. The key factor for retarding the growth of the self-acquired disorders is streamlining the eating pattern. Depleting levels of phytochemicals is directly been linked with introducing the complication of CVD's in type 2 diabetes [36]. Anthocyanins have exhibited anti-diabetic properties. It has

suggested that anthocyanins lower blood pressure, protection to β-cells, insulin sensitivity, slowing down the absorption of sugars and increasing the insulin secretion (37). Particularly, the antioxidative properties of these compounds are found to be more influential.

Recently extract of cherry sticks has been observed for rendering a significant role on the blood glucose, glycosylated haemoglobin (HbA1C) and major components of renal functioning tests i.e. creatinine and uric acid [38]. These results have enlightened the role of anthocyanins directly on preventive action of the complications of diabetes mellitus. Dietary supplement from blueberry and sea buckthorn have shown the elevated levels of antioxidative enzymes as superoxide dismutase and glutathione peroxidase [39]. This can be suggested that enhanced levels of these enzymes will boost the metabolic activity in engulfing the free radicals and progression of complications will be hampered.

These studies suggest the indispensable role of anthocyanins on the pathogenesis of disorders at all cellular levels. The structural dependency of anthocyanins needs to be explored and their effects on type of cells need to be investigated. Berries have an eminent role to play in combating the progression of lifestyle disorders.

CONCLUSION

Increasing evidence demonstrates the health benefits of fruits and vegetables, attributed to the additive and synergistic interactions of the phytochemicals present in them. Similarly, the available evidence from the literature points out that anthocyanin-based bioactive phytochemicals have the potential to be of use in combating different lifestyle disorders such as cancer, oxidative stress, CVDs, diabetes, etc. for human sustenance. Therefore, consumers should obtain nutrients and bioactive phytochemicals from a wide variety of fruit and vegetables for optimal nutrition and health well-being, without ignoring the coloured ones.

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