THE PHENOLIC COMPOUNDS IN BERRIES: BENEFICIAL EFFECTS ON HUMAN HEALTH

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Abstract

The phenolic compounds in fruits are secondary plant metabolites and are mainly associated with the nutritional as well as the sensorial properties of fruits. These compounds not only affect the aroma of the fruits, but are also found to have profound effects on human health due to their antioxidant, anti-inflammatory and antimicrobial effects. Berry fruits, including blueberry, cranberry, raspberry and strawberry, are good sources of a wide variety of phenolics. The major phenolic compounds in berries include: flavonoids, phenolic acids, tannins, stilbenes and lignans. Studies upon the effects of these phytochemicals have revealed that these compounds are important antioxidants. Furthermore, the increased consumption of berries that are naturally rich in phenolic compounds is found to be associated with the prevention of cardiovascular diseases, diabetes, cancer, and obesity. In nature, the phenolic compounds found in plant tissues protect the plants against bacterial and fungal infections, UV radiation, physical damage, etc. Based on this knowledge, the beneficiary effects of the phenolic compounds are nowadays being investigated with respect to the increased consumers' concern towards healthy and natural type of nutrition. This review summarizes, the major phenolic compounds found in berry fruits and their beneficial effects on human health.

Keywords: *phenolics, flavonoids, berries, health effects*

Introduction

The increased concern of consumers towards food products rich in nutraceuticals has led to an increased interest in the research about the bioactive compounds in fruits and vegetables. In this respect, the berries, an important fruits group, that is mainly preferred for their specific sweet-to-sour taste, aroma and colorful fruits are mainly investigated not only for their nutritional properties, but also for their bioactive constituents (Landete, 2012; Paredes-Lopez et al., 2010).

The berries, including blueberry, cranberry, raspberry and strawberry, are known to be good sources of a number of bioactive compounds such as vitamins and phenolics having an antioxidant activity (Hannum 2004; Pappas and Schaich, 2009; Paredes-Lopez et al., 2010; Serrano et al., 2009).

Phenolics in food products of plant origin are secondary plant metabolites that are known to protect plants from UV light, infections or act as attractants for pollinators (Landete, 2012; Naczk and Shahidi, 2006). Chemically, phenolics comprise a diverse group of phytochemicals that have one or more phenol group in their structure and these compounds may be present in plants as simple molecules, oligomers or polymers. The phenolic compounds in berries may be found in the form of simple phenolics, phenolic acids, flavonoids, stilbenes, hydrolysable and condensed tannis, and lignans. These compounds are known to contribute to the bitterness, astringency, color, flavor and odor of fruits. The berry fruits are mainly preferred for their specific aroma and taste, and for centuries, they comprise an important part of the human diet. On the other

hand, before the development of modern medicine these fruits were used in the healing of various diseases and are well-known in folk-medicine (Hannum, 2004; Landete, 2012; Pappas and Schaich, 2009; Paredes et al.; 2010). This fact has increased the interest in exploring the healing effects of berries and recently considerable research revealed that the phenolics in berries have significant beneficial effects upon human health.

The main aim of the present study is to review the phenolic compounds found in berries and their beneficial effects on human health.

Phenolics in Berries

The main phenolic compounds found in berries include phenolic acids, flavonoids (flavonols, anthocyanins, catechins), stilbenes, hydrolysable and condensed tannins (proanthocyanidins), and lignans (Fig. 1). Berries are known to be rich sources of phenolic acids, catechins, anthocyanins and proanthocyanidins. In blueberries, cranberries and strawberries, considerable amounts of phenolic acids such as gallic acid, ferulic acid, caffeic acid, p-coumairc acid, ellagic acid, sinapic acid, vanillic acid were detected (Hannum, 2004; Naczk and Shahidi, 2006; Pappas and Schaich, 2009). Berries have been found to be the major source of condensed tannins in the diet. Blackberries and raspberries are known to be the best dieatary sources of hydrolysable tannins including ellagitannins (Paredes-Lopez et al., 2010; Serrano et al., 2009). The flavonols, such as quercetin and kaempferol, are found in abundance, especially in cranberries (Pappas and Schaich, 2009). Furthermore, the anthocyanins that are responsible for the color of many plants are found mainly in the skin of fruits. Cyanidin, pelargonidin, delphindin, peonidin and mailvidin are the major anthocyanins present in berries. Stilbenes are phenolic compounds with relatively low molecular weight and berries are their major source. The stilbenes present in berries include reseveratrol, pterostillbene and piceatannol (Paredes-Lopez et al., 2010).

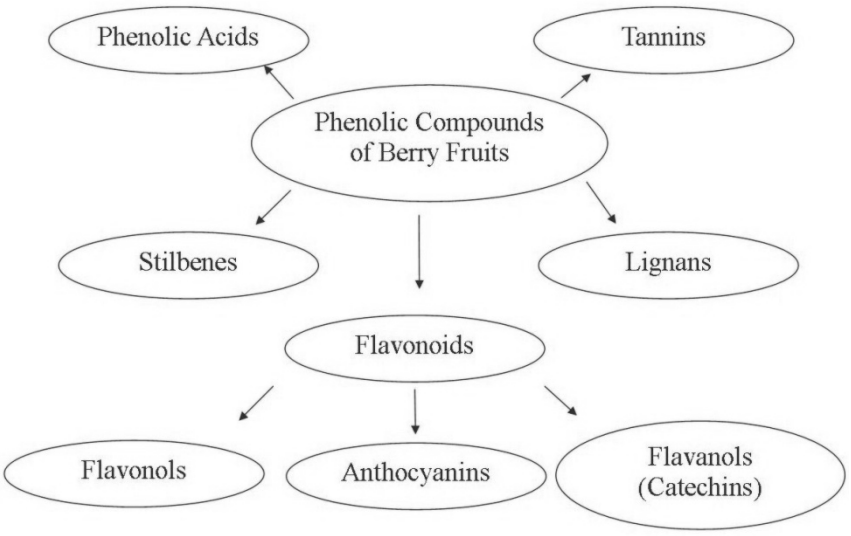

Figure 1. Classification of phenolic compounds in berry fruits (Paredes-Lopez et al., 2010)

The Beneficial Effects of Berries

The phenolics naturally found in plants are known to exhibit some antimicrobial effects. They are known to protect plants against infections. The medicinal use of berries since ancient times is well-known and research has revealed their healing effects. For example, in folk medicine, cranberry juice was used for healing urinary tract infections and recent studies verified the antibacterial effects of cranberries (Pappas and Schaich, 2009). On the other hand, research of the bioavailability and health effects of phenolic compounds have revealed that these compounds have even more beneficial effects such as preventing and/or decreasing the risk of cardiovascular diseases, cancer, diabetes, Alzheimer's disease and arthritis (Basu et al., 2010; Lee et al.; 2012). There is a strong concern about the correlation between intake of natural fruits and the decreased risk of the above mentioned chronic disorders. The beneficial health effects of phenolics naturally found in berries are mainly due the properties of these compounds presented in Figure 2.

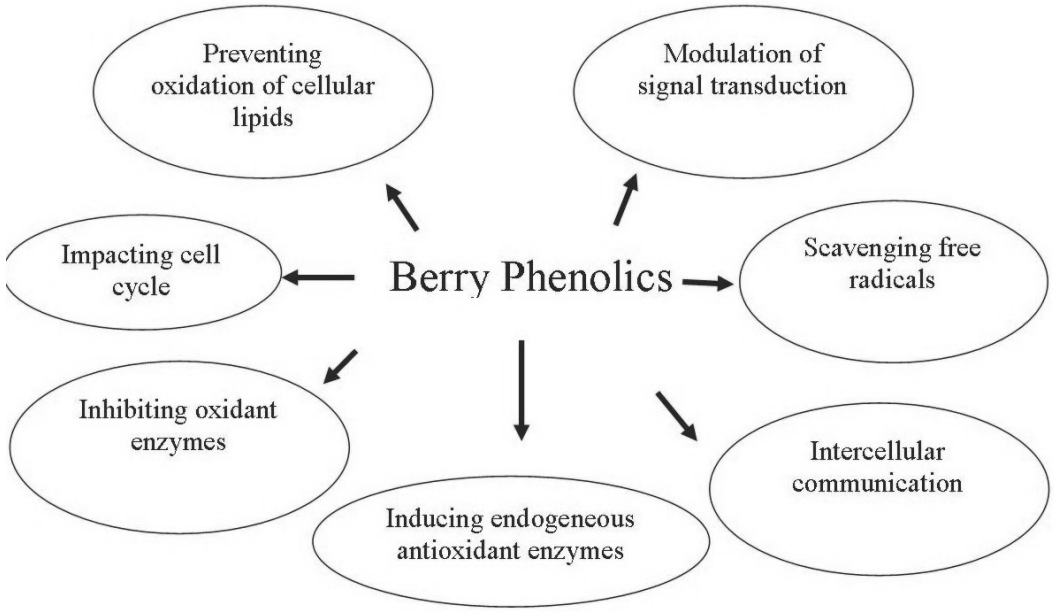

Figure 2. Figure 2. Properties supporting the beneficial effects of berries (Basu et al., 2010)

The phenolics in berries have been shown to have excellent antioxidant capacities. The mechanism of the antioxidant activity phenolic compounds present in berries was found to be in several ways: scavenging free radicals, chelating transition metals, inhibiting prooxidant and oxidant enzymes, inducing endogenous antioxidant enzymes and preventing lipid oxidation (Basu et al., 2010; Landete, 2012).

Diabetes and obesity are some of the main health problems that are paid attention as the ratio of humans affected by these disorders is found to increase among people. The tannins present in abundance in berries are known to have anti-nutrient effects thus leading to a decreased absorption of some nutrients and are therefore proposed for the reduction of the risk of obesity. The phenolics in berries were found to lower the blood glucose levels, increase insulin sensitivity, thus leading to a decreased risk of diabetes (Landete, 2012; Paredes-Lopez et al.; 2010).

Incorporation of berries into human diet was correlated with the decreased risk of cardiovascular diseases. After berry intervention the following findings have been observed:

- An increase in plasma or urinary antioxidant capacity;
- A decrease in LDL oxidation and lipid peroxidation;
- A decrease in plasma glucose or total cholesterol;
- An increase in HDL-cholesterol (Basu et al., 2010)

The anthocyanins present in berries were suggested as the main factors in reducing the risk of cardiovascular diseases. Furthermore, the phenolics in berries are known to have preventing effects in some neurodegenerative diseases such as Alzheimer's disease and atherosclerosis. The mechanisms of these effects are still to be revealed, but it is proposed that berry phenolics are effective by decreasing the oxidative stress (Lau et al. 2006).

The main beneficial effects of polyphenolics in berries are summarized in Table 1.

CONCLUSION

Phenolics present in abundance in berries appear to have significant beneficial effects. Considerable research about the potential effects of these compounds has been done up to now. Although, phenolics in berries emerge as important dietary constituents with health benefits, the required intake of these compounds still remains to be determined. Based on the revealed benefits, some medicines for weight loss have been prepared from extracts of various berries. But, as the maximum intake amounts are still to be revealed, researchers mainly advise the natural intake of the berry fruits.

Table 1. Effects of polyphenolic compounds (Landete, 2012; Hannum, 2004)

Effect	Example
Antioxidant activity	- Correlation between polyphenols and total antioxidant activity - Inhibition of LDL oxidation - Protection of DNA from oxidative damage
Antimcrobial activity	-Inhibition of the growth of Clostridium spp., Escherichia coli and Salmonella spp, Staphylococcus spp.
Anti-inflammatory activity	-Modulation of pro-inflammatory gene expression such as lipoxygenase, nitric oxide synthesases -Beneficial effects in the treatment of ischemia and neurodegenerative diseases
Prebiotic effects	-Favoring the increase of Bifidobacterium and Lactobacillus counts
Vasodilation	-Decrease in blood pressure

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