

Review

Functional components of berry fruits and their usage in food technologies

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In recent years, nutritious features of foods produced and consumed as well as their roles in disease prevention have been taken into consideration. It has been reported in numerous studies that food habits are connected with many illnesses including cancer. It is reported that some components with anti-oxidative effects which are present in different quantities in berry fruits reduce the negative effects brought out by free radicals that serve as agents in those ailments. Additionally, doubts about artificial anti-oxidants which are being used in industry have increased the tendency in consumption of natural anti-oxidant sources such as berry fruits. The effects of processes carried out in food industry are considerably significant on functional components of these fruits that are used for different purposes. So, some points that require utmost care in order to minimize loss are necessary to be determined. In this review, we will focus on functional components of berry fruits, detection methods of these components, their presence rates in different berry fruits, possibilities of using them as functional foods and the effect of food processes on these components.

Key words: Berry fruits, antioxidant, food process.

INTRODUCTION

There is direct relationship between nourishment and health. Use of nutritious foods help in increasing life expectancies and increase resistance against many diseases like, cancer, obesity and some cardiovascular diseases. Good food habits lead consumers to expect various benefits from foods they buy together with their nutrition (Ethertan et al., 2002). There has been increase in research pertaining to foods called functional foods in recent years. These foods bear components far beyond basic nourishment and have positive effects on health. Blandol et al. (2007) reported that production and consumption of these foods have increased manifolds during recent years.

One of the most common components in functional food production is use of anti-oxidants. Anti-oxidants are important substances that are used in food industry to prevent rotting and help long storage, transportation and easy marketing without deteriorating quality of the product. There are hundreds of natural or synthetic compo-

nents used as anti-oxidants. The interest on use of anti-oxidant in diet from natural sources (phytochemicals) has been increasing.

Free radicals are taken as a result of physiological activities, various external agents or nourishment and have roles in curing numerous chronic illnesses, notably cancer and aging (Shahidi, 2004; Ekici and Sağdıç, 2008). Besides this harmful effects of free radicals are controlled by natural defense systems in body, that are necessarily supported by natural anti-oxidant components taken through diet (Koca and Karadeniz, 2005; Astley, 2003).

Berry fruits including raspberry, blackberry, strawberry, viburnum opulus and huckleberries that grow naturally in various parts of Turkey are included in the group of fruits with high amounts of anti-oxidant capacity (Miller et al., 2000). With the rapid developing functional food sector in the recent years, use of these fruits as functional components has increased as they include basic components in the form of anti-oxidants.

This review describe functional components of berry fruits, their detection methods, their percentage in different fruits, using possibilities in functional foods and the

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effect of food processes on these components.

Functional components of berry fruits

Most of the fruits and vegetables include functional components in grate scale as polyphenols, flavonoids, fibre, linoleic acid isomers, gallate, epigallocatechin, soya protein, isoflavonons, A, B, C, E vitamins, tocoferoles, Ca, Se, chlorophyll, sulphides, catechin, uric acid and protease inhibitors (Karakaya and Kavas, 1999). A review of the previous research shows that flavonoids, vitamin E, phenolic acids, phenols, carotenoids and vitamin C are the most commonly found components in berry fruits. Phenolic compounds cause oxidation resulting in different problems during the processing of fruits and vegetables. Anthocyanins are present in cellular juice in form of glycoside which is formed by conjugation of one substance that is glucose and one another which is not (Cemeroğlu and Acar, 1986). Blackberries, raspberries and strawberries each are good sources of anti-oxidants (Heinonen et al., 1998).

These functional components present in berry fruits have various positive effects like protection against different ailments, binding of free radicals and prevention of lipid peroxidation in foods. Therefore, to make use of these positive effects their consumption should be taken as behaviour (Çağlarırnak, 2006).

GC/MS (Gas chromatography / Mass spectrometer) (Kafkas et al., 2006; Türemiş et al., 2003), spectrophotometer (Akbulut et al., 2007; Özgen and Scheerens, 2006; Miller et al., 2000) and HPLC (Henderson et al., 1999) are used most commonly used to determine phenolic components. Additionally, total anti-oxidant capacity, is determined by TROLOX which is a synthetic vitamin E and is used as a standard anti-oxidant. It binds free radicals or stop oxidation of foods total anti-oxidant capacity of food is expressed as; TEAC (trolox equivalent anti-oxidant capacity), ORAC (free radical clearance) or DPPH (diphenyl picrylhydrazyl scavenging activity) (Wu et al., 2004; Huang et al., 2005).

Functional components and features of berry fruits have differences. At the same time, environmental factors are effective in changing these differences (Eyduran et al., 2008). In a study carried out by Elmastaş and Gerçekçioğlu (2006), 3 different tests were used to determine anti-oxidant activities of some berry fruits. The results showed that *viburnum opulus* is the fruit with highest anti-oxidant capacity, according to total anti-oxidant test, raspberry is found to be the fruit with highest anti-oxidant capacity. In rosehip, phenolic component ratio is found to be less but ascorbic acid ratio is determined to be much more than other fruits. In this study, phenolic components and derivatives are said to be metabolites that are primarily responsible for anti-oxidant activity in plants.

In a study carried out by Özgen and Scheerens (2006), anti-oxidant capacities of some black and red raspberries

were compared. While no more difference was observed between types in terms of photochemical ingredients and anti-oxidant capacity, in respect to black ones, red raspberries. They found more than 80% total phenolic matter and approximately 6 times more anthocyanin. Anti-oxidant capacities of black raspberries are two times more than red ones. Especially, high anthocyanin (2176 - 2417 µg/g) and total phenolic (2853 - 3102 µg/g). It is therefore of primary importance to use black raspberries in cancer treatment.

Blackberries and raspberries grow naturally in almost all parts of Turkey, especially in black sea region. These fruits include high amounts of polyphenol like anthocyanin (Eyduran et al., 2008a; Eyduran et al., 2008b). While high pigmented berry fruits like blackberry and raspberry have the highest anti-oxidant capacity (5100 - 5500 TE) (Türemiş et al., 2003).

Functional components differ in berry fruits according to harvest period. In a study carried out by Wang and Lin (2000), on leaf and fruit of different culture kinds such as spineless raspberries (*Rubus* sp.), red raspberries (*Rubus idaeus*), black raspberries (*Rubus occidentalis*) and strawberries (*Fragaria ananassa*), total phenolic and total anthocyanin ingredients were determined by ORAC method. While maximum total anti-oxidant capacity and total phenologic components in raspberry and flowers are present in green period, these values are at highest in raspberry when the fruit is ripe. The amount of total anthocyanin increased in all three types as the fruits ripened. The same study determined that as the leaves get older, total phenolic and total anti-oxidant capacities decreased. As the ripe fruits are analysed, it is found out that anthocyanin ingredients of black raspberries and blackberries were high after red raspberries. In another study, anti-oxidant capacities of ripe black raspberries, strawberries, blackberries and red raspberries were determined and anti-oxidant ingredients of black raspberries and blackberries were found more compared to red raspberries and strawberries. Cyanide glycoside which is a powerful anti-oxidant is found in higher amounts in black raspberries and blackberries (Macheix et al., 1990). Besides, strawberries are reported to be rich in pelargonid-3 glycoside (Gil et al., 1997).

Usages of berry fruits in industry

Natural components that are consumed in different ways are used for healing increase functional features of food and are used in food formulas.

Berry fruits are more commonly consumed fresh on the table. In food technologies, they are also used to extract fruit juice, make fruit syrup, jam and marmalade ice-cream, fruit yogurt and fruit milk, candy, cake and gum and some bakery products. In the functional food sector berry fruits are also being used for preparation of natural herbal teas. During production, the effects of processes applied on especially functional components of berry

fruits should be given due importance.

Drying of berry fruits

Even the presence of berry fruits and dried fruits in daily diet in lesser amounts is enough to supply anti-oxidants in significant amounts. For anti-oxidant capacity is damaged to lesser extents during drying. For instance, drying grape increases its anti-oxidants 4.3 times (Miller et al., 2000).

In this patent study conducted, it is stated that solid powder mixtures obtained from fruit seeds or fruit seed fractions could be used in the production of foods like cake, muffin and yogurt. Thus, these foods are supported by anti-oxidants, linoleic acid, soluble and insoluble diet fibre that are good for health (Yu and Moore, 2007).

It's usage in fruit-juice production

In the recent years, production and consumption of functional food has increased throughout the world (Menrad, 2003). Because high amounts of functional components are present in berry fruits and their juice, it is advised that they should be used to prevent illness and promote healthy living habits (Bermúdez-Soto and Tomás-Barberán, 2004). Berry fruits are rich in anthocyanin and anti-oxidant components like ascorbic acid (Burdurlu et al., 2005). There is a direct correlation between anti-oxidative activity of a food and total phenolic substance it includes (Elmastaş and Gerçekçioğlu, 2006; Velioglu et al., 1998). In a study carried out by Netzel et al. (2002), it is found out that, by consumption of a special fruit-juice mixture composed of berry fruits, a significant increase took place in anti-oxidant capacity of blood and products brought out by lipid peroxydase decreased.

Yu and Moore (2007) report from different researches that seed oils and wheat of various berry fruits that can also be used in fruit-juice production, significant amounts of α -linolenic acids and natural anti-oxidants detected. At the same time, these seeds and their fractions can be included as tocopherole, caratonoids and as natural colour taste and aroma agents. All of these components may be used to increase nutrition value, quality and security of different food formulas.

Their usage in bakery products

Diets enriched with fruits and vegetables are marvellous sources of anti-oxidants (Ness and Powles, 1997). Experimental epidemiological studies shows that, there is a significant relationship between cereal, fruit and vegetable consumption and lesser amounts of catching illnesses (Greenberg and Sporn, 1996; Jacobs et al., 1998).

Anti-oxidant capacities of cereals, fruits and vegetables display significant differences. The average anti-oxidant

capacity of cereal products is either equal to fruits or vegetables or more than that. For instance, anti-oxidant capacities of melon and water-melon are less than 100 TE (Trolox Equivalents/100 g sample), anti-oxidant capacities of berry fruits is extremely high (1900 - 5500 TE) (Miller et al., 2000).

Berry fruits especially are also used as sweetener to aromate and are used as colorant in functional cereal products for breakfast. Dried huckleberry commonly added into berry fruits especially are used as sweetener aroma and colorant in functional cereal products for breakfast. Cereal products for breakfast, it can also be used for enrichment of instant cereal products in form of powder. Huckleberries are reportedly used as whole or sweetened in flake products commercially (Batu and Kırmacı, 2006).

Fruits and vegetables serve as good anti-oxidant sources, but all cereal products for breakfast bear a considerable amount of anti-oxidants equal in weight. When anti-oxidant capacity is 2000 TE in whole meal bread, this value is accounted as 1200 TE in white bread. In dry weight, these values are 3000 and 1800 TE respectively. The difference between the breads is due to the existence of bran and embryo in whole-meal bread. On the other hand, there is a different based on the type of the wheat. The anti-oxidant capacity of red wheat is more than those of others (Miller et al., 2000). For this reason, products produced by using white flours with increasing the anti-oxidant components by berry fruits can be investigated.

During baking bakery products in oven, carcinogenic agents including acrylamide can be produced in relation with Maillard reaction. In a study conducted, the effects of two plants anti-oxidant feature on acrylamide well-known are used in bread production and acrylamide formation is detected to have decreased (Hedegaard et al., 2008). Similarly, it is expressed that, undesired Maillard reaction in UHT milks is prevented by anti-oxidants in green tea (Schamberger and Labuz, 2007). These studies give ideas about using possibilities of berry fruits with various different foods.

Their usage in special foods

In the diet of celiac patients, there should be enough amounts of fibre. These fibres can be supplied from different plant sources. Although all fruits include fibre, raspberry and blackberry are reported to be rich in fibres; taste, aroma and fibre source of berry fruits, regulating beneficial process (digestion) in mammals can be used in bakery products to produce gluten free cake (Arendt and Bello, 2008).

Their usage as additive

One of the important usages of berry fruits in food industry is their use as natural colorant. Technologically

processed meat, vegetable, fruit, bakery and dairy products are tried to be turned into the colours they had before the procession.

Nutritious fibres that are present in fruits have no important role. But solvable fibres such as pectin that are present in huckleberries can decrease glisemic index by delaying digestion of carbohydrates and sugar absorption which precede just afterwards (Camire, 2000).

Anti-oxidants have a wide variety of usage in food industry. By protecting foods against rotting, these components enable them to be stored for a long time. Some of these components are buthylised hydroxytolien (BHT) and buthylised hydroxylanisol (BHA) components. In the recent years, because of synthetic anti-oxidants like BHT and BHA and doubts about safety of using them in long scale, there is an ever increasing tendency of using natural anti-oxidants (Gazzani et al., 1998; Yu and Moore, 2007). In the recent years, because of synthetic anti-oxidants like BHT and BHA and doubts about safety of using them in long scale, there is an ever increasing tendency of using natural anti-oxidants (Gazzani et al., 1998; Yu and Moore, 2007). In a similar study, anti-oxidant capacity of raspberry is found to be 83.2% while this value for BHT was 88.8% (Elmastaş and Gerçekçioğlu, 2006).

Biscuits produced by using 3 different plant extracts with high anti-oxidant content are compared with the synthetic anti-oxidant (BHA) including biscuits and control biscuits. Natural plant extracts have displayed perfect anti-oxidant effect. Acid and peroxide values that show oxidation level after 6 weeks of storage are found to be lower (Reddy et al., 2005).

Effects of food processes on anti-oxidant capacity

The food's anti-oxidant capacity may be affected by processes like baking, peeling and boiling. In a study carried out, the effect of baking and boiling processes on anti-oxidant capacity of different vegetables is investigated (Wu et al., 2004). Baking is significantly affecting anti-oxidant capacity. For instance, while anti-oxidant capacity did not change in white potato, this amount decrease in carrots and increased in tomatoes. The reason why different foods are affected by baking in different scales may be related directly by their natural structure and molecular structures of anti-oxidants they include. Researchers are in the belief that foods that include flavonoids and poliphenolic components are more stable than the foods that include vitamins and related components (Wu et al., 2004). For there is limited data about the effects of process on anti-oxidant components in fruits and vegetables.

Skrede et al. (2000) have studied changes in anthocyanin and poliphenolic components of frozen raspberries (*Vaccinium corymbosum* L.) during processing into fruit-juice and concentrated products. While the yield of fruit-juice obtained from raspberry is 83%, anthocyanin

passed into fruit-juice is only 32%. Some of these functional substances (1 – 18%) are determined to be left in pomace. The loss in anthocyanin and phenolic components are expressed to be caused by the activity of natural poliphenolic oxidase enzyme during pressing and depectinisation processes. The amount of anthocyanin in pasteurized fruit-juice is higher (4%) than the one found in pressed fruit-juice. This is said to be caused by inactivation of enzyme, which was active during solution and pressing processes, by pasteurisation.

Ge'linas and McKinnon (2006) stated that the concentration of phenologic components increase a bit during baking white bread. This condition is reported to be because of products that are formed by the conclusion of Maillard reaction. Hansen et al. (2002) says that all process steps (kneading, fermentation and baking) in producing black bread have the least effect on total phenologic components. However, Friedman (2004) thinks that baking destroys many phenolic components.

After jam production process, in plum, cherry and raspberry fruits, more than 73% of total phenolic substances and 65% of anti-oxidant capacity is preserved. These ratios may be increased by optimisation activities carried out (Kim and Zakour, 2004; Ötleş and Çağındı, 2005).

Conclusion

Fruit and vegetable rich diets include anti-oxidants in considerable amounts and their preventing cancer is proved by many researches. Within the fruits, the ones with highest anti-oxidant rates are berry fruits. In order to make use of beneficial effects of them in terms of health, they should be consumed life-long in optimum amounts. These fruits (raspberry, blackberry and rosehip) that have good effects on human health grow in wild within Turkey and we would better generalise good features of these fruits and people should be encouraged to consume berry fruits. In order to get the maximum benefit, harvesting periods of berry fruits should be well determined and the young leaves should especially be studied.

Berry fruits are being used in food industry for many purposes such as source to main components, natural anti-oxidant source, taste and colour substance etc. The studies conducted to determine functional components in these fruits can be used instead of synthetic components like BHT and BHA. Steps in food processing such as drying, boiling, pasteurisation, depectinisation and baking in oven are affecting functional components in berry fruits. On the other hand, it is stated that, by optimization studies concerning formulation, the losses in these significant components can be reduced. There is limited data about the effects of processes on these components of fruits, there is need for such studies. Additionally, further studies are also necessary to point out the effects of these components on health and food.

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