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Herbal beverages: Bioactive compounds and their role in disease risk reduction - A review

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ABSTRACT

There is a renewed interest in non-nutritive bioactive compounds of foods and beverages as 'lifespan nutrients' in the risk reduction of non-communicable diseases. Herbal beverages, consumed as part of a balanced diet, may improve the antioxidant status and enhance the overall health status. Herbal teas/beverages are rich sources of natural bioactive compounds such as carotenoids, phenolic acids, flavonoids, coumarins, alkaloids, polyacetylenes, saponins and terpenoids, among others. A wealth of available scientific evidence demonstrates that natural bioactive compounds render a number of diversified biological effects, such as antioxidant, antibacterial, antiviral, antiinflammatory, antiallergic, antithrombotic and vasodilatory actions, as well as antimutagenicity, anticarcinogenicity and antiaging effects. A number of herbal beverages are consumed globally and some beverages have gained more popularity than others depending on their geographical origin. However, in the era of globalization, ethnic barriers have gradually been removed and such commodities although from different areas, are now universally available as international health-pro products.

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1. Introduction

Excessive generation of reactive oxygen species (ROS) in the body causes oxidative stress, an injurious process leading to the oxidation of biomolecules such as proteins, lipids, carbohydrates and DNA. Oxidative stress is well known for its pivotal role in the etiology of several non-communicable diseases (NCDs) such as cardiovascular diseases, arthritis, type 2 diabetes, different types of cancer, autoimmune diseases and neurodegenerative disorders, among others.¹ The human body has endogenous antioxidant defense mechanisms those act simultaneously against ROS. These include enzymes (catalase, superoxide dismutase, glutathione reductase, glutathione peroxidase), low-molecular-weight antioxidants (uric acid, glutathione, albumin, protein-SH groups, bilirubin) and certain vitamins (ascorbic acid, α -tocopherol) as well as carotenoids.² However, external sources of antioxidants are needed

to prevent oxidative damage in the human body once internal antioxidant defense systems are challenged by over exposure to free radicals and other ROS.

There is a renewed interest in natural non-nutrient antioxidative compounds in reducing the incidence and severity of NCDs. Antioxidant compounds are widely distributed in plant materials, animal tissues and microorganisms. Fruits, vegetables, cereals, legumes, oilseeds, teas and certain spices are important sources of plant-derived antioxidants.³

Herbal beverages, commonly known as teas, have gained popularity among health conscious consumers. They have penetrated into an emerging niche market along with other popular beverages such as tea, coffee and cocoa which are also prepared using plant materials. In addition, a rapidly growing segment of the population uses herbal beverages for slimming, weight loss and a number of other cosmetic purposes.

In general, herbal beverages are prepared from natural ingredients of different morphological plant parts, namely leaves, stems, roots, fruits, buds and flowers. Herbal teas/beverages are rich sources of natural bioactive compounds such as carotenoids, phenolic acids, flavonoids, coumarins, alkaloids, polyacetylenes, saponins and terpenoids, among others. Scientific evidence shows

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that these bioactive compounds render a myriad of biological effects, such as antioxidant, antibacterial, antiviral, antiinflammatory, antiallergic, antithrombotic and vasodilatory action, as well as antimutagenicity, anticarcinogenicity and antiaging effects, among others.^{4–6} This contribution provides an overview of constituent antioxidants, and bioactivities of herbal beverages.

1.1. Antioxidants

Antioxidants are known for their ability to inhibit or delay the oxidation of other molecules in food and biological systems. They are protective against oxidative stress via different mechanisms and modes of action that are often independent of their antioxidant effect and may render their effects cooperatively via several mechanisms. These modes of action include free radical scavenging, singlet oxygen quenching, inactivation of peroxides and other ROS, metal ion chelation, quenching of secondary oxidation products, and inhibition of pro-oxidative enzymes, among others.⁷

Antioxidants are naturally present in many foods. Further, they can be synthesized, similar to their natural counterparts, such as synthetic vitamins C and E. Synthetic antioxidants generally contain of a phenolic ring and one or more hydroxyl substituents. Synthetic antioxidants that are still used by the food industry include butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), propyl gallate (PG), and *tert*-butylhydroquinone (TBHQ). However, there are concerns associated with potential carcinogenic effect of some of these synthetic antioxidants at high concentrations in animal models which limits their use in food applications and a desire by the consumers to have green label products devoid of synthetic additives.⁷

1.2. Herbal beverages

The commonly used tea is a beverage made from leaves and buds or twigs of the plant *Camellia sinensis*, and is only second to water, the most consumed beverage in the World. There are basically four major types of true teas, namely black tea, oolong tea, green tea, and white tea. Nevertheless, the term herbal tea/beverage usually refers to infusions with fruit or other herbs that do not contain *Camellia sinensis*. Herbal beverages are also called tisane, herbal infusion, or botanical infusion to avoid confusion with true teas. Herbal beverages can be made with fresh or dried flowers, immature fruits, leaves, seeds, and/or roots by steeping (infusion) or boiling (decoction) of the source materials including herbs.

Herbal beverages when consumed within a balanced diet, may improve the antioxidant status, and reduce oxidative stress in humans.⁸ In addition, many commonly consumed herbal beverages do not contain any detectable caffeine levels as in coffee and tea. Health Canada categorizes herbal beverages under natural health products (NHPs). However, according to Health Canada moderate consumption (2–3 cups/day) of selected herbal teas such as citrus peel, lemon balm, ginger, orange peel and rosehip is recommended during pregnancy and breastfeeding.⁹

Herbal beverages have been used as natural part of the food culture in countries where traditional medicines are widely used. For instance, herbal teas prepared from *Aegle marmelos* (Bael), *Cassia auriculata* (*Ranawara*), *Aerva lanata* (*Polpala*), and *Hemidesmus indicus* (*Iramusu*) are common social beverages of food cultures in India and Sri Lanka. China is another country where combined herbal teas are often drunk on a daily basis to promote health and reduce the risk of certain health-related issues of different severity as simple as cold to diseases of liver and other organs.

Herbal teas consist of one or more herbal substances intended

for oral consumption and prepared by means of decoction, infusion or maceration. Generally the tea is prepared immediately before use. However, ready-to-serve bottled herbal beverages are becoming popular. Herbal teas are usually supplied in bulk form or in sachets. The herbal substance (s) used in tea formulations may be processed in advance by means of drying, comminuting and crushing. Therefore, commercially available products may be in different forms such as whole dried plant parts, dried powder, dried particles within tea bags, as well as granulates, and solutions which can be consumed directly. Table 1 presents selected examples of herbal beverages commonly used by populations around the world to boost optimum health as well as for reducing the risk of a number of disease conditions such as hyperglycemia, dyslipidaemia, cancer, and hypercholesterolemia.

2. Antioxidant compounds in herbal beverages

2.1. Phenolic compounds

Phenolic compounds are ubiquitous in plant organs. They are secondary metabolites consisting of an aromatic ring with different degrees of hydroxylation.³ Phenolics are derived from biosynthetic precursors such as pyruvate, acetate, aromatic amino acids such as phenylalanine and tyrosine, acetyl CoA and malonyl CoA following the pentose phosphate, shikimate, and phenylpropanoid metabolism pathways.¹⁰ Phenolic compounds occurring in herbal beverages include phenolic acids, coumarins, flavonoids, tannins, lignans and lignins.

2.2. Phenolic acids

Two classes of phenolic acids, hydroxybenzoic acids and hydroxycinnamic acids are found in plants.³ Hydroxybenzoic acids (C₆-C₁) include gallic, *p*-hydroxybenzoic, vanillic, syringic, and protocatechuic acids, among others. The hydroxycinnamic acids, better known as phenylpropanoids (C₆-C₃), include *p*-coumaric, caffeic, ferulic, and sinapic acids.³ Herbal beverages have been reported to include a number of phenolic acids.

2.3. Flavonoids

Flavonoids are synthesized by condensation of a phenylpropanoid compound with three molecules of malonyl coenzyme A. This reaction is catalyzed by the enzyme chalcone synthase that leads to the formation of chalcones. The chalcones are subsequently cyclized under acidic conditions to form flavonoids.³ There are different subclasses of flavonoids, namely flavones, flavonols, flavonones, flavononols, isoflavones, anthocyanidins and flavanols. Flavones and flavonols are present as aglycones in foods.³ They have similar C ring structures with a double bond at the 2–3 positions. Flavones lack a hydroxyl group at the third position.³ Flavonols (quercetin, kaempferol, and myricetin), flavones (luteolin, apigenin and chrysin), flavanols (catechin, epicatechin, epigallocatechin, epicatechin gallate, and epigallocatechin gallate), flavanones (narigenin, hesperitin, and eriodictyol), anthocyanidins (cyanidin, malvidin, peonidin, petunidin, pelargonidin and delphinidin), and isoflavones (genistein, daidzein, and glycitein) are the commonly found flavonoids in the human diet. Flavonoids, namely catechin, quercetin, kaempferol, rutin, apigenin, and isorhamnetin are constituents of the aqueous infusions of flower, leaf and seed of *Sideritis condensata*¹¹ (Table 2). In addition, flower infusion prepared within 10 min time contained 15 mg of isorhamnetin per gram of dry matter.

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