

Phytochemicals From Food Plant Residues-An Approach To Environmental Clean-Up

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Abstract—Increased consumption of 'ready to eat' foods in modern lifestyle has resulted in several health problems. Natural health-protective and disease-preventive products are in great demand nowadays due to both consumers' preference and health concerns. By-products of fruits and vegetables from commercialization and industrial transformation are an interesting and cheap source of medicinal and nutritional ingredients, especially when huge amount of byproducts are produced (sometimes 50% of the harvested material). In this context, development of health-care products from fruit and vegetable residues could be a feasible approach for their value added utilization contributing to environmental clean-up at the same time through their safe and efficient disposal. Present status and future prospect for lucrative application of food plant residues as sources of phytochemicals and nutraceutical compounds and their cleansing impact on environment are discussed in the paper.

Key Words: Phytochemicals, Nutraceuticals, Agri-food byproducts

Introduction

Epidemiological studies have related the dietary consumption of fruits and vegetables, with a decrease in the incidence of cancer and cardiovascular disease mortality (Rimm *et al.*, 1996; Doll,

1990). This has been associated to the content of phytochemicals as one of the key factors. The main bioactive phytochemicals in fruit and vegetables include polyphenols, terpenoids, glucosinolates and other sulphur-containing compounds. Clinical studies support the role of the plant food phytochemicals as health-promoting food constituents (Kris-Etherton *et al.*, 2002; Scalbert *et al.*, 2002). These are secondary metabolites that have an ecological role in plant tissues as insect feeding deterrents, UV screens and as attractant to ensure pollination and seed dispersal among other functions. By these reasons the phytochemicals are preferentially biosynthesised in the external plant tissues. These external parts are the main waste material during handling and processing of fruits and vegetables and constitute a good source for extraction of phytochemicals.

Natural antioxidants are in great demand nowadays due to both consumers preference and health concerns associated with the use of synthetic antioxidants. The role of antioxidant phytochemicals in the prevention of these diseases has been mainly attributed to the prevention of LDL oxidation (Scalbert *et al.*, 2002; Rankin *et al.*, 1993) through a scavenging activity against peroxyl and hydroxyl radicals (Rankin *et al.*, 1993). These compounds are also responsible for different quality characteristics, including colour, flavour and aroma of fruits and vegetables and related food products.

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The changes of the modern lifestyle have resulted in increase of consumption of the "ready to eat" foods (canned, refrigerated, etc) that generally contain small amounts of health-promoting compounds. Functional foods try to contribute to a proper dietary habit by providing foodstuffs with 'added-value': adding new ingredients that increase their health-promoting properties by increasing bioavailability of active compounds, etc. In this context, addition of phenolic-enriched extracts derived from by-products could be a feasible strategy to develop functional foods and at the same time would contribute to valorize of these by-products.

The main sources of fruit and vegetable waste production from commercialization and industrial transformation originate in the packing houses where external leaves and low quality products are discarded in the fresh-cut industries where peels and external tissues are removed and in the extraction industries where the press-cake residues (pomaces) constitute an important residue. The packing houses dealing with vegetables produce large amounts of wastes and residues (leaves, stems, etc.). Sometimes these by-products could reach 50% of the harvested material as in lettuce and cauliflower. In general, such by-products have traditionally been used as animal feedstuff and for fiber and fuel production. Fruit wastes like orange, grape, apple and olive residues from processing industries are used to produce extracts. An interesting approach to give an added value to these materials is their use as sources of phytochemicals and natural antioxidant compounds, mainly phenolic compounds which in some cases have comparable activity to that of synthetic antioxidants (Azizah *et al.*, 1999; Lu and Foo, 2000). A number of by-products have been previously studied as potential sources of antioxidants (onion, carrot, potato peel). The resi-

dues from orange juice extraction industries have already been exploited for many years for the extraction of flavanones (hesperidin and related compounds) and pectin. Grape wastes from the wine-making industries (grape pomace and seeds) are also used industrially for the extraction of anthocyanin pigments, procyanidins and polyphenol extracts (Gabrielska *et al.*, 1997; Lu and Foo, 1999). From the olive-oil extraction industries the residues can also be used for extraction of hydroxytyrosol (Visioli *et al.*, 1999), the main phenolic antioxidant in olive oil and an efficient process for this purpose has been developed. The apple pomaces are already used for extraction of pectins. Recently process has been developed to use the tomato-juice production residues for the extraction of lycopene, a bioactive terpenoid pigment.

However, the use of vegetables byproducts as a possible source of antioxidant phenolics is scarcely reported. Exploitation of vegetable residues from commercialization and processing for extraction of phytochemicals is actually less developed. The phytochemical compositions of vegetables such as artichoke, cauliflower, lettuce, etc., and biological actions of their chemical ingredients have been studied. The results obtained indicate that by-products of these vegetables are an interesting and cheap source of antioxidant phenolics, especially when considering the huge amount of byproducts that are produced by both the fresh and fresh-cut industries.

Bioactive Phytochemicals from Vegetable Byproducts

The Artichoke by-products are a very good source of antioxidant polyphenols with caffeic acid derivatives as main phenolic compounds (Llorach *et al.*, 2002). The antioxidant activity has been proved with different assays showing special capacity to prevent the peroxidation of linoleic acid (Llorach *et al.*, 2002). Analysis of cauliflower by-

product extracts revealed the presence of both flavonoids and hydroxycinnamic acids (caffeic acid and sinapic acid). Different combinations of flavonols such as kaempferol and quercetin with sinapic acid and glucose have been identified being the main compounds kaempferol-3-O-sophoroside-7-O-glucoside and its sinapoyl derivative (kaempferol-3-O-(sinapoylsophoroside)-7-O-glucoside). The cauliflower by-products showed a relevant antioxidant capacity, estimated from their ability to reduce TPTZ-Fe(III) complex to TPTZ-Fe(II). In this way, 16 g (d.w.) of cauliflower by-products can provide the same antioxidant capacity than one cup of tea or one glass of red wine (Llorach *et al.*, 2003). Phytochemical profile of lettuce by-product is composed of hydroxycinnamic acids and flavonoids. The main hydroxycinnamic acid derivative identified was dicaffeoyltartaric acid followed by chlorogenic acid. In addition different isomers of isochlorogenic acid were identified. Flavone viz., Luteolin-7-O-glucuronide, quercetin-3-O-glucoside, quercetin 3-O-glucuronide and quercetin 3-O-(6-O-malonyl)-glucoside have been identified. Lettuce by-products have shown an interesting antioxidant capacity both free radical scavenging activity and capacity to reduce Fe(III) to Fe(II).

Quality and Safety

Before producing extracts and phytochemicals from fruit and vegetable residues, it is essential to evaluate the potential market and price for these products. Safety of these products is also an important aspect. It is essential to make sure that the pesticides and other agrochemicals are not concentrated in the extracts in the same way the phytochemicals are. It is also important to establish the risk/benefit balance of using these phytochemical extracts for health-related purposes. In addition, it is necessary to control the content of

the bioactive phytochemicals in the extracts by appropriate analytical methods. The biological activity of these phytochemical extracts needs to be demonstrated by *in vivo* studies and clinical assays.

Conclusion

Agri-food residues are very perishable products whose management is not always easy and are responsible for environmental management problems in the industries. Minimizing their environmental impact has been the subject of an increasing concern in recent years. Using wastes and residues of the fruit and vegetable industries as a source of beneficial bioactive phytochemical can be a feasible option for addressing this important issue. Production of preparation of such value added products is technologically feasible and they can be obtained at relatively low cost. It is however essential to guarantee the product safety. The biological activity of these products needs further research. The main objective of this field of research should be the recuperation of the health-promoting metabolites that are lost during handling and processing thereby managing environmental problems resulted from improper disposal of agri-food wastes.

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