

Characterisation of onion (*Allium cepa* L.) by-products as food ingredients with antioxidant and antibrowning properties

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Abstract

Processing and stabilising onion wastes (residues and surpluses of onion) could solve the environmental problem derived from a great onion wastes disposal. Moreover, obtaining stabilised onion by-products as natural antioxidant food ingredients could be advantageous to food industry, not only to improve the use of onion wastes but also to obtain new natural and functional ingredients. The aim of this study was to characterise onion by-products – juice, paste and bagasse – from two Spanish onion cultivars – ‘Figueres’ and ‘Recas’ – that have been stabilised by thermal treatments – freezing, pasteurisation and sterilisation – in order to evaluate the effect of the processing and stabilisation treatment on the bioactive composition, antioxidant activity and polyphenol oxidase (PPO) enzyme inhibition capacity. The results obtained triggered to choose one onion by-product offering better characteristics for its potential development as a food ingredient: source of antioxidant and antibrowning bioactive compounds. In this study it was shown that processing of ‘Recas’ onion wastes to obtain a paste (mixture content) and applying a mild pasteurisation were the best alternatives to obtain an interesting stabilised onion by-product with good antioxidant properties that made useful its use as functional food ingredient.

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1. Introduction

Onion (*Allium cepa* L.) is one of the major vegetable crops grown in Europe which production and cultivated area has increased constantly since 1998. More than 450,000 tonnes of onion wastes is produced annually in the European Union, mainly in UK, Holland and Spain. Nowadays, the food and agricultural products processing industries generate substantial quantities of phenolic-rich by-products, which could be valuable natural sources of antioxidants to be employed as ingredients. Some of these by-products have been the subject of investigations and have proven to be effective sources of phenolic antioxidants

(Balasundram, Sundram, & Samman, 2006; Peschel et al, 2006).

There is a concern over the production of large quantities of industrial onion waste or by-products and its disposal. Onion wastes are not suitable for fodder, or landfill disposal due to the rapid growth of phytopathogens, e.g. *Sclerotium cepivorum* (white rot). Valorisation of by-products, particularly exploitation of them for profitable production of food-grade products will benefit the onion producers and processors (Lecain, Ng, Parker, Smith, & Waldron, 1999).

Processing and stabilising onion wastes (residues and surpluses of onion) could represent both advantages: a solution of the environmental problem derived from the great onion wastes disposal and the obtaining of stabilised onion by-products as natural antioxidant food ingredients. Spain is one of the major Mundial onion-producing coun-

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tries. It produced 936,827 tonnes of onion in a cultivated area of 21,324 hectares in 2003. Different varieties and cultivars of onion are spread out among all the regions of Spain, being Castilla-La Mancha, Levant and Andalusia the main producing areas. Catalonia produced 55,368 tonnes of onion in 2004. Onion industry produces wastes that yield an approximated 15% of the total production that is annually changeable. Therefore, this variability among harvests every year leads the industry to have an onion overproduction those years with a high volume of onion production. The 90% of onion produced in Catalonia is cultivated in Lleida. In Catalonia the production in 2004 was 18,250 tonnes of 'Recas' onion cultivar, 13,600 tonnes of 'Figueres' onion cultivar and 3000 tonnes of the rest of onion cultivars and varieties.

Onion nutritional composition is very complex. It has been shown that it is one of the major sources of dietary flavonoids in many countries. Specifically, onion has been characterised for its flavonol quercetin and quercetin derivatives. Moreover, it is rich in other bioactive compounds such as fructooligosaccharides and sulfur compounds.

Epidemiological studies have indicated that the consumption of fruits and vegetables is associated with a reduced risk for the development of chronic diseases, such as cardiovascular disease and cancer. Phytochemicals, including phenolics and flavonoids, are suggested to be the major bioactive compounds contributing to the health benefits of fruits and vegetables (Yang, Meyers, Van der Heide, & Liu, 2004). Quercetin is one of the abundant flavonol-type flavonoids commonly found in vegetables and fruits (Moon, Nakata, Oshima, Inakuma, & Terao, 2000). Onion ranked highest in quercetin content in a survey of 28 vegetables and 9 fruits (Hertog, Hollman, & Venema, 1992). It shows a variety of pharmacological effects such as growth inhibition of tumour and microbial cells, reduction of cancer risk, scavenging of free radicals, and protection against cardiovascular disease, which are attributed to specific sulfur-containing compounds and flavonoids (Ly et al., 2005). In addition, onions have been found to have antioxidant properties in different *in vitro* models (Kim & Kim, 2006; Nuutila, Puupponen-Pimiä, Aarni, & Oksman-Caldentey, 2003).

A number of by-products have been previously studied as potential sources of antioxidants. In fact, an interesting approach to utilise by-products is their potential use as sources of natural compounds with high antioxidant activity (Larrosa, Llorach, Espín, & Tomás-Barberán, 2002). Onion wastes adequately processed and stabilised could be useful in the food industry as functional ingredients to be added to processed foods due to the increasing demand by consumers for substituting synthetic compounds by natural substances as food ingredients. Compounds of inherently natural origin would be widely accepted by consumers in the market (Jang, Sanada, Ushio, Tanaka, & Ohshima, 2002).

Nowadays, one of the major concern for the food industry is to prevent the development of enzymatic browning

prior to or during the processing of fruits and vegetables because of the alteration in the organoleptic and visual properties of the product. A quality loss is also a fact to take into account due to the phenolic compounds content decrease that occurs during the enzymatic browning (Tomás-Barberán & Espín, 2001). Recent studies have shown that sulfhydryl (SH or thiol) groups are good inhibitors of the enzyme PPO (Ding, Chachin, Ueda, & Wang, 2002). Therefore, it is assumed that the thiol compounds contained in onion might be the active components responsible for the PPO inhibitory effect of onion. Onion extracts could be used as natural food ingredients for the prevention of browning caused by PPO (Kim, Kim, & Park, 2005).

In this work, we attempt to evaluate onion by-products stabilised by different treatments in order to show their bioactive, antioxidant, and antibrowning properties. This would trigger to choose the onion by-product showing better characteristics for its potential use as antioxidant and antibrowning food ingredient.

2. Materials and methods

2.1. Chemicals

Acetonitrile and methanol were obtained from Labscan Ltd. (Dublin, Ireland). Di-sodium hydrogen phosphate anhydrous, sodium dihydrogen phosphate monohydrate, and sodium carbonate anhydrous were purchased from Merck KGaA (Darmstadt, Germany). Hydrochloric acid and *ortho*-phosphoric acid were purchased from Panreac Química, S. A. (Barcelona, Spain). Catechol, chlorogenic acid, 2,2-diphenyl-1-picrylhydrazyl (DPPH), Folin-Ciocalteu's phenol reagent, polyvinylpyrrolidone, and quercetin were obtained from Sigma-Aldrich, Inc. (St. Louis, MO, USA).

2.2. Samples

2.2.1. Onion by-products. Processing and stabilisation treatments

'Figueres' and 'Recas' onion wastes from the harvesting period of 2005 (*Allium cepa* L. var. *cepa*) were supplied by a producing onion industry, CEBACAT (Asociación Catalana de Productores y Comercializadores de Cebolla) in Lleida (Catalonia, Spain). Their processing and stabilisation was held in The National Center for Food Technology and Safety (CNTA) in San Adrián (Navarra, Spain). Stabilised onion by-products analyses were performed in Instituto del Frío, Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain.

Previously, onions wastes roots were removed and sheered with a 10 × 10 mm rack. Then, these onions were processed with a friction screw press to obtain the following three onion by-products: onion juice (the liquid fraction), onion paste (a mixture between the solid and the liquid fractions) and onion bagasse (the solid fraction).

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