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A Review on Extraction of Phytochemicals from Onion Leaves

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Abstract*: An experimental setup based on a 23-full factorial, central composite design was implemented with the aim to optimising recovery of polyphenols from onion solid wastes (OSW). In order to allow for the establishment of a sustainable process, reusable and non-toxic solutions composed of water/ethanol/citric acid were employed as extracting media. The factors considered were (i) the pH of the medium, (ii) the extraction time and (iii) the ethanol concentration. The model obtained produced a satisfactory fitting of the experimental data with regard to total polyphenol extraction (R2 = 0.97, p = 0.0025) and the reducing power of the extracts (R2 = 0.97, p = 0.0033), but not with the antiradical activity (R2 = 0.89, p = 0.0592). The 2nd order polynomial equations obtained after elaboration of the experimental data indicated that all parameters considered were significant in respect with the efficiency of total polyphenol recovery. The highest total polyphenol yield was theoretically predicted to be 9342 ± 1435 mg gallic acid equivalents per 100 g dry weight, under optimal conditions (60% EtOH, pH 2 and 4.2 h). Liquid chromatography-electrospray ionisation mass spectrometry of the optimally obtained extract revealed that the principal phytochemicals recovered were quercetin 3,4'-diglucoside, quercetin 4'-glucoside and quercetin. Simple linear regression analysis between the total polyphenol and the antiradical activity of the OSW extracts showed that there was no correlation in a statistically significant manner, as opposed to reducing power.*

Keywords: Allium cepa, Antiradical activity, Onion Polyphenols Response surface Wastes

I. INTRODUCTION

Fruits and vegetables are an essential part of the human diet, partly because of their content in natural antioxidants, especially avonoids, which may play a bene cial role in the maintenance of normal physiological functions (Huang, Wang, Eaves, Shikany, & Pace, 2007). In many in vitro experiments, dietary avonoids having a catechol (1,2-dihydroxybenzene) group have been shown to inhibit oxidation of biomolecules by: (i) acting as free radical scavengers via donation of hydrogen atoms or electrons, (ii) binding proteins and enzymes involved in the generation of reactive oxygen species (ROS), (iii) complexing transition metal ions able to catalyse ROS formation by redox cycling, and (iv) regenerating potent endogenous antioxidants, such as a-tocopherol (Cook & Samman, 1996). Moreover, uncontrolled oxidation of biomolecules (e.g., nonenzymatic lipid peroxidation) has been reported to take place during cell degeneration, tumour promotion, coronary heart diseases and some forms of cancer (Olinski, Gackowski, Rozalski, Foksinski, & Bialkowski, 2003; Trushina & McMurray, 2007). Importantly, it is now increasingly recognised that avonoidsmay exert favourable health effect by regulating the expression of genes involved in the in ammatory response, the metabolism of carcinogens and the antioxidant defence (Havsteen, 2002). Quercetin is the most common avonol aglycone. It is present (usually as glycosides) in a wide range of fruits and vegetables and particularly abundant in onion, which is one of the tasteful members of the genus Allium and a major source of antioxidants (sulphur compounds, avonoids) (Corzo-Martinez, Corzo, & Villamiel, 2007; Rhodes & Price, 1996; Stratil, Klejdus, & Kubn, 2006). Two major groups of avonoids found in onions are anthocyanins (cyanidin and peonidin glycosides) (Donner, Gao, & Mazza, 1997) and avonols(quercetin, isorhamnetin, kaempferol and their glycosides) (Grif ths, Trueman, Crowther, Thomas, & Smith, 2002). The most abundant avonols in onions are quercetin 40-O-b-D-glucoside and quercetin 3,40-O-b-D-diglucoside, which account for more than 85% of the total avonoid content (Bonaccorsi, Caristi, Gargiulli, & Leuzzi, 2008; Stratil et al., 2006). Moreover, red onions are richer in avonols than yellow, and pink onions (Prakash, Singh, & Upadhyay, 2007). Red onions also display anthocyanins, which not only impart red colour but also participate in their strong antioxidant activity. In contrast to red-skinned onion, white onions contain only trace levels of

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Phytochemicals in Onion Leaves

This section provides an overview of the key phytochemicals identified in the leaves of Ficus racemosa

- **Flavonoids**: These compounds are known for their antioxidant, anti-inflammatory, and anticancer properties.
- **Tannins:** Tannins possess antimicrobial, anti-inflammatory, and wound-healing effects.
- **Alkaloids:** Alkaloids in Ficus racemosa are often associated with analgesic and anti-inflammatory effects.
- **Phenolic Compounds:** Phenolic acids, such as caffeic acid, provide antioxidant activity, which is crucial for combating oxidative stress-related diseases.
- **Saponins:** Saponins are known for their antifungal and antidiabetic properties.
- **Terpenoids:** These compounds exhibit various biological activities, including antimicrobial and anti-inflammatory effects.

Extraction Methods of Phytochemicals

Extraction is a critical initial step in isolating bioactive compounds from Onion. Several techniques have been utilized, each with its advantages and limitations, depending on the target compounds and the desired yield. This various methods of extracting bioactive compounds from Onion leaves, comparing traditional and modern techniques are as follows:

Solvent Extraction

The most common method, which involves using solvents like ethanol, methanol, hexane, and chloroform to dissolve phytochemicals.

Advantages: High yield of extracts, simple and inexpensive.

Disadvantages: Solvent residues can be toxic if not properly removed, and some phytochemicals may be lost due to degradation.

Soxhlet Extraction

A continuous extraction process using a solvent, typically ethanol or methanol, to extract phytochemicals over an extended period.

Advantages: Efficient extraction with minimal loss of compounds.

Disadvantages: Energy-intensive and requires specialized equipment.

Ultrasonic-Assisted Extraction (UAE)-

Utilizes high-frequency sound waves to enhance solvent penetration and the release of phytochemicals from plant tissues.

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Advantages: Faster extraction with higher yields and reduced solvent use.
Disadvantages: Requires ultrasonic equipment, which can be costly.

Microwave-Assisted Extraction (MAE)-
Uses microwave radiation to heat the solvent and plant material, enhancing extraction efficiency.
Advantages: Faster extraction, improved yield, and lower solvent consumption.
Disadvantages: Requires specialized equipment, and some phytochemicals may degrade under intense heat.

Supercritical Fluid Extraction (SFE)-
Employs supercritical carbon dioxide (CO_2) to extract phytochemicals.
Advantages: High selectivity for specific compounds, no solvent residues.
Disadvantages: Expensive and requires high pressure and temperature conditions.

Water Extraction (Infusion and Decoction)-
Traditional methods where water is used as a solvent, either by infusing or boiling plant material.
Advantages: Simple, safe, and environmentally friendly.
Disadvantages: Low extraction efficiency compared to solvent-based methods.

Maceration Process

Biological Activities of Phytochemicals in Onion Leaves-

This are the pharmacological activities of the bioactive compounds extracted from Onion leaves:

Antimicrobial activity

In folk medicine, garlic and onion have been used for centuries in several societies against parasitic, fungal, bacterial and viral infections. Recent chemical characterisation of their sulphur compounds has allowed stating that they are the main active antimicrobial agents (Rose, Whiteman, Moore, & Zhu, 2005). However, some proteins, saponins and phenolic compounds can also contribute to this activity (Griffiths, Trueman, Crowther, Thomas, & Smith, 2002). Due to the great antimicrobial

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Antioxidant activity

Oxidation of DNA, proteins and lipids by reactive oxygen species (ROS) plays an important role in aging and in a wide range of common diseases, including cancer and cardiovascular, inflammatory and neurodegenerative diseases, such as Alzheimer's disease and other age-related degenerative conditions (Borek, 1997, Richardson, 1993).

Research studies evidence that plant-based diets, in particular those rich in vegetables and fruits, provide a great amount of antioxidant phytochemicals, such as Anticarcinogenic and antimutagenic activities

The modern era of the use of garlic as anticancer agent begins in the 1950s when Weisberger and Pensky (1958) demonstrated *in vitro* and *in vivo* that thiosulfinate extracts from garlic inhibited the tumor cells growth. Since these investigations, many epidemiological and laboratory studies have been developed to evidence the garlic and related *Allium* species (as onion) chemopreventive or anticarcinogen effects. In particular, their capacities to inhibit the tumor growth and the cellular

Effects related to cardiovascular diseases

There are many factors associated with arteriosclerosis and cardiovascular diseases, among which can be included: elevated blood cholesterol and triglycerides levels, including LDL; increased platelet activity; elevated blood homocysteine; diabetes; hypertension; and obesity. These cardiovascular disease risk factors are mainly determined by uncontrollable causes (heredity, gender and age) and lifestyle-related causes (smoking, inactivity, stress and diet), which are possible to be modified.

Effects on the respiratory system

Certain onion-derived compounds, in particular thiosulfinates and cepaenes, show a remarkable *in vitro* inhibitory effect of cyclooxygenase and lipoxygenase mediated reactions which initiate eicosanoid metabolism and lead to bronchial restriction. Therefore, these compounds have antiasthmatic activity (Wagner, Dorsch, Bayer, Breu, & Willer, 1990). It has been described that, in general, saturated thiosulphinates are less active than unsaturated ones and that cepaenes are more active than

Immunomodulatory effect

Recent investigations are beginning to clarify important roles of immune functions modulation in some diseases progression. Currently, available data suggest that garlic may be a promising candidate as a biological immune response modifier, being able to maintain the homeostasis of immune function, stimulating necessary functions and suppressing unnecessary functions (Kyo, Uda, Kasuga, & Itakura, 2001).

A great variety of immunomodulatory effects have been studied in different garlic-derived

Other beneficial effects

In addition to the above mentioned biological activities, it has been observed that AGE may protect the small intestine against antitumor drugs-induced damage, for example, nauseas, vomits, diarrhoea, stomatitis and gastrointestinal ulceration, and, consequently, intestinal dysfunction (Capel et al., 1979, Horie et al., 2001). It has been reported that onion stimulates the digestive process, accelerating digestion and reducing food transit time in the gastrointestinal tract (Platel &

Applications of Phytochemicals from Onion Leaves

The bioactive compounds derived from Onion leaves offer immense potential in various industries, such as pharmaceuticals, neutraceuticals, and cosmetics companies.

Antimicrobial: Onion leaves can have antimicrobial properties
Anti-inflammatory: Onion leaves can have anti-inflammatory properties
Antioxidant: Onion leaves can have antioxidant properties
Antidiabetic: Onion leaves can have antidiabetic properties
Anticancer: Onion leaves can have anticancer properties
Hepatoprotective: Onion leaves can have hepatoprotective properties
Bronchodilator: Onion leaves can have bronchodilator properties

II. CONCLUSION

Onion i.e. Onion leaves are a rich source of bioactive phytochemicals with significant therapeutic potential. Their diverse pharmacological activities, ranging from antioxidant and anti-inflammatory to the antimicrobial and anticancer effects, make them valuable in various industrial applications, including pharmaceuticals, nutraceuticals, and cosmetics. However, further studies are necessary to optimize extraction methods, identify additional compounds, and explore the full range of applications for these phytochemicals. By unlocking the potential of a Onion leaves, new, natural alternatives for health and wellness could be developed, contributing to the global demand for sustainable and effective treatments.

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