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Extended Abstract

Optimizing the Extraction of Effective Compounds from Onion By-products Using Microwave Dry-diffusion and Gravity Method

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Abstract

One of the most advanced extraction techniques of effective components is microwave dry-diffusion and gravity extraction (MDG) which are applicable in both laboratory and industrial scales. The aim of this study was extraction of onion by-products by MDG. In this research, face-center design was used in order to investigate the effect of two independent variations: extraction time (10, 15 and 20 min) and microwave power (300,500 and 700 W) on quality properties consisted of the yield of total phenolic, quercetin, the antioxidant activity and extraction yield. According to the results, the best treatment was in the time of 20 min, extraction power of 500 W. Under these conditions, most antioxidant compounds were extracted consisted polyphenol compounds, 67.47 (mg/kg), quercetin, 30.37 (mg/100g), ferric ion reducing antioxidant power, 542.09 (Mm/g) and DPPH free radical scavenging activity, 37.60%. All concentrations of onion by-product extract had antimicrobial activity, but the effect of the minimum inhibitory concentration of the extract on different microorganisms (*Aspergillus niger* mites, *Staphylococcus aureus* and *Escherichia coli* bacteria) was not the same. So its effect on mold of *Aspergillus niger* and *E. coli* bacteria was much higher than that of *Staphylococcus aureus*. The results showed that, there is a significant difference between the effective compounds of extract with this method and the solvent extraction technique (P<0.05). The process of microwave hydro diffusion and gravity proposed a fast technical and efficient method for extraction of extracts from plants and their by-products in comparison with conventional hydro distillation method.

Keywords: Antioxidant, Extraction, Microwave Hydro Diffusion and Gravity, Onion By-Product

Introduction

In recent years, the use of food by-products such as grape skin, citrus peel, apple pomace, potato peel, and onion and saffron petals has been the focus of attention (Weisburger, 1999).

Studies have shown that *Allium* family plants were an important source of dietary flavonoids that had a special role in the nutrition and supply of minerals, vitamins and sugars (Hertog, Hollman, & Katan, 1992; Tepe, Sokmen, Akpulat, & Sokmen, 2005). The flavonoids in onions were essentially glycosides of quercetin and kaempferol and showed antioxidant activity (Brand-Williams, Cuvelier, & Berset, 1995). Microwave dry- diffusion and gravity method is based on the microwave heat (sound temperature, frequency and frequency) and the gravitational field force (Vian, Fernandez, Visinoni, & Chemat, 2008). For this reason, the system was extracted at all-time points in the extraction sites Extraction of natural compounds is an economical, high-efficiency, energy-efficient, solvent-free and environmentally friendly approach. In this research, by using microwave dry gravity diffusion apparatus and gravity, polyphenolic compounds were extracted from onion waste.

Materials and methods

Total phenolic content (TPC)

TPC of onion extracts was measured by Folin-Ciocalteu method (Lister & Wilson, 2001).

Determination of antioxidant capacity

DPPH free radical scavenging assay

The DPPH free radical-scavenging activity of onion by-product extracts (pre-diluted to 90 mg/L concentration) was evaluated by DPPH assay by (Siger, Nogala-Kalucka, & Lampart-Szczapa, 2008).

Determination of ferric reducing/antioxidant power (FRAP assay)

Ferric reducing-antioxidant power (FRAP) was determined using 2, 4, 6-tripyridyl-s-triazine (TPTZ) by the method of (Benzie & Strain, 1999).

Quercetin content

Quercetin was determined using by the method of (Chang, Yang, Wen, & Chern, 2002)

Determination of minimum inhibitory concentration of microorganisms using disk release method

The antimicrobial properties of onion waste extracts were determined by the minimum inhibitory concentration method (Sindambiwe *et al.*, 1999). The drop rate of bacterial and mold growth was determined by disk diffusion method (Sandri, Zacaria, Fracaro, Delamare, & Echeverrigaray, 2007).

Results and discussion

Influence of extraction process conditions on the amount of total phenolic compounds

Total polyphenol content increased over time (20 min) and with increasing power (700 W). In general, the results of this study showed that extraction time has more effect on the extraction rate of polyphenol than power.

Impact of extraction process conditions on antioxidant activity

DPPH radical-scavenging capacity

In the microwave hydro diffusion and gravity technique, the antioxidant compounds increased by increasing the extraction time to 15 min and then decreased to 20 min by increasing the time. Consequently, more time is not useful to extract antioxidant compounds, which is consistent with the results of (Silva, Souza, Rogez, Rees, & Larondelle, 2007). As shown in Fig. (1), the highest DPPH was in the first 20 min at 500 W (40%) and the lowest at 700 W at 10 min (30.5%).

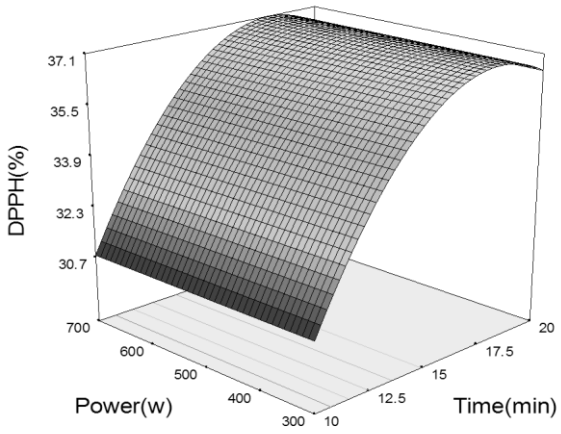

Fig. 1. Response surface chart; influence of time (minutes) and power (w) on the free radical power of extract extracted from onion waste

Ferric reducing/antioxidant power criterion

The reduction of ferric ions in the FRAP reagent was caused by the formation of blue. As shown in Fig. (2), the ferric ion reduction force increased with increasing power to 500 W and time up to 15 min at first (320 μmol 2-valent iron) and then increased (420 μmol 2-valent iron). The highest FRAP was at 300 W for 20 min (673.09 μmol 3 g/dl) and the lowest was at 500 W and 15 min (150.66 μmol /g).

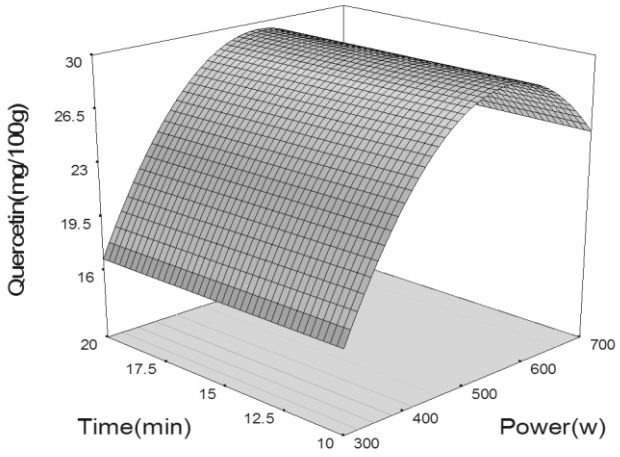

Fig. 2. Response surface chart; influence of time (minutes) and power (w) on the free radical power of extract extracted from onion waste

Effects of extraction parameters on quercetin content

As can be seen in Fig. (3), the extraction parameter had the greatest effect on quercetin and significantly (P<0.05) increased quercetin extraction. Since quercetin is a heat-resistant flavonoid compound (da Costa, Filho, do Nascimento, & Macêdo, 2002). Therefore, by increasing the power up to 500 W, which also increases with temperature, its solubility is increased and the extraction efficiency is increased.

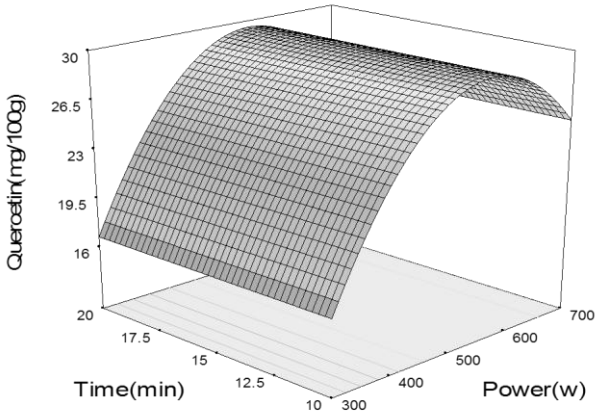

Fig. 3. Response surface diagram; effect of time (minutes) and power (watts) on polyphenol content (mg gallic acid/kg) extract extracted from onion waste

Evaluation of minimum inhibitory concentration of onion waste extract in optimum microwave and gravity diffusion process

As can be seen in Table (1), all concentrations of onion extract had antimicrobial activity, but the effect of the extract on different microorganisms was not the same. So that its effect on mildew and negative gram bacterium *Escherichia coli* was much higher than its effect on *Staphylococcus aureus*. As the concentration of the extract increased from 200 to 250 mg/mL, the mean diameter of the microorganisms increased.

Table 1. Effect of onion waste extract in comparison with synthetic nitrate preservative Sodium on average diameter of *Aspergillus niger*, *Escherichia coli* and *Staphylococcus aureus*

Sample	Inhibitory Area (Mm)		
	Staphilococus aureus	*Escherichia coli*	*Aspergilus niger*
Onion extract (200 mg/mL)	13.33±0.72[a]	13.45±0.42[a]	11.29±0.15[b]
Onion extract (250 mg/mL)	14.64±0.35[a]	14.86±0.87[a]	12.17±0.28[b]
Sodiom nitrat (0.1%)	15.20±0.78[a]	14.88±1.08[a]	13.30±0.31[b]

Conclusions

The MDG method is a combination of high efficiency microwave extraction, distillation and gravity extraction techniques, which is a rapid and low solvent, low environmental contamination method and is an eco-friendly extraction method for extraction. The effect of onion waste extract against *Aspergillus niger* and gram-negative *Escherichia coli* was more than that on gram-negative *Staphylococcus aureus*. Also, the antimicrobial effect of the extract at a concentration of 250 mg/mL on *Aspergillus niger* mold was approximately equivalent to the synthetic preservative of sodium nitrate, while its antibacterial effect was much higher than that of sodium nitrate.

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