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Total Phenolic Content and Anti-oxidant Capacity of Some Spices and Herbs Grown in Vietnam

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Abstract

In recent years, the obesity and oxidative stress are the most common factors affecting the human health. Especially, the rancid foods are plentiful with free radicals, which trigger chronic diseases such colon cancer, breast cancer, heart diseases and so on. Therefore, this study focuses on the determination of the levels and activities of polyphenols extracted from some spices and herbs applied to traditional Vietnamese foods. The results categorized these plant materials into 3 sub-categories including one group shows the high total phenolic content and antioxidative ability (green tea leaves, green guavas and buffalo spinach leaves). The second group has low total phenolic content, but high in antioxidant capacity (tungho leaves, onion, elsholtzia leaves, green mangoes, basil leaves, lemongrass leaves, coriander leaves, green amberella, turmeric roots, ginger roots, galangal roots) and the last group possessed the lowest total phenolic content and antioxidant activity (lemon leaves).

INTRODUCTION

In last two decades, the problems of rancidity and deterioration of high fat content foods, which reduce food quality and are harmful for human health due to the oxidative reactions of fats and oils, were concerned. Oxidation inhibitors and antioxidants could be used to prevent the auto-oxidation of fats and oils in processed foods (Adegoke et al., 1998). For a long time, synthetic antioxidants such as butylated hydroxyl anisole (BHA), butylated hydroxy toluene (BHT) and *tert*-Butylhydroquinone have been used as antioxidants for high fat and oil foods (Branen et al., 2001). However, in some countries, these antioxidants have been restricted to apply into foods because of their toxicity (Gazzani et al., 1998). This promoted the development of various alternative antioxidants derived from natural plants that have been received much attention as sources of biologically active substances not to prevent fat and oil oxidation of food but to reduce the risks of cancer development (Siddiqui et al., 2013; Dillard and German, 2000).

There are a lot of papers reported that phenolic compounds in plants are responsible for high anti-oxidative capacity and anti-microbial activity (Huang et al., 2012; Amin et al., 2006; Chu et al., 2000). It was reported that polyphenol are rich in many plants such as fruits, herbs and spices (Perron and Brumaghim, 2009). The typical structural characteristic shared by most polyphenols is the three-membered flavan ring system (Perron and Brumaghim, 2009). Besides, it is resumed that polyphenols can suppress the development of harmful bacteria such as *Staphylococcus aureus*, *Salmonella*, *Escherichia coli* and *Vibrio* in foods

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(Taguri et al., 2004). Therefore, evaluation of phenolic content and their anti-oxidant capacity is necessary to further estimate about the impaction of these plant extracts on food quality (Siddiqui et al., 2013).
In Vietnam, many spices and herbs such as galangal, turmeric, onion and ginger roots; amberellas, green mangoes and guavas; coriander, lemongrass, basil, lemon, marjoram, tungho, green tea and buffalo spinach leaves have been used to delay the spoilage and rancidity of traditional foods. However, there is a few study carried out about anti-oxidative capacity and total phenolic content of these materials. The present experiment determines the antioxidant potential of some plant materials to facilitate the effectiveness of using these plant extracts to protect foods from auto-oxidation and bacteria.

Materials and methods

Plant meterials

Spices in the forms of roots (ginger, turmeric, onion and galangal) and leaves (basil, elsholtzia, lemograss, green tea leaves, tang ho, coriander, buffalo spinach) were purchased from Go Vap market, Hochiminh city, Vietnam while lemon, guava and mango leaves were collected from some garden in Long An province, Vietnam.

Extraction processes

Raw materials were classified on the color quality characters. Sands, yellow seared and damaged leaves were removed, washed, and drained in order to get the good quality of materials. Then, they were blanched to de-activate polyphenoloxidase (an enzyme of phenolic oxidation) in 30 sec and immediately later soaked into ice water in duration of 15 min. Next, these materials were grinded into small particles to improve the extraction yield. After that, 50g blanched spices were added into 1250 ml distilled water. Then, microwave assisted extraction technique used to obtain phenolics from materials with the treatment power and treatment time of 280W and 4 min, respectively. The crude extracts were allowed to cool at room temperature before filtering by China cloths and Whatman papers. The filtrates were used to determine TPC and IC50 values.

Determination of total phenolic content

Total phenolic contents (TPC) from the extracts were quantified using Folin–Ciocalteu's method with slight adjustment (Pinelo et al., 2005). First, 5 ml Folin – Ciocalteu reagent was added to 1 ml sample in tube. Then, 4 ml of 7.5% (w/v) sodium carbonate was added to mixture. After 60 minutes of incubation at room temperature (32 ± 1^{o}C), the absorbance was read at 765 nm against blank (solvent used for extraction). A standard curve was plotted using gallic acid (0–200 mg/mL). The results were expressed as milligram gallic acid equivalent per gram dry weight basis of fresh sample (mg GAE/g dw basis).

Determination of antioxidant activity

Radical scavenging activity of extracts was measured by the slightly modified method of (Pinelo et al., 2005), as described below. Briefly, 1 ml of extracts was diluted at different concentration was added to tube. Then, 4 ml of 0.1 mM DPPH in ethanol was added to this tube. The absorbance was measured at 515 nm after 20 min of incubation at 37^{o}. Free radical scavenging activity was expressed as percentage of inhibition:

$$\text{DPPH scavenging effect} = [(A_0-A_1)/A_0]\times 100$$

Where, A_0 was the absorbance of the control and A_1 was the absorbance in the present of the sample.

Statistical analysis

Results were expressed as mean ± standard deviation of triplets. The software of Statgraphic version 3.0 was used to data statistic. Excel 2007 software was applied to verify the experimental design model.

Table 1. TPC and anti-oxidative capacity of various extracts from fruits, spices and herbs

No	Common name	Abbreviate	Scientific name	TPC (mgGAE/100g)	Anti-oxidative capacity (ppb)
1	Galangal roots	GLR	*Languas galanga*	442.6 ± 69.1	3554.9 ± 55.6
2	Turmeric roots	TR	*Curcuma longa*	670.0 ± 10.8	1464.3 ± 23.7
3	Onion	ONi	*Allium cepa*	2135.5 ± 82.6	1819.3 ± 11.8
4	Ginger roots	GGR	*Zingiber officinale*	503.6 ± 50.0	2568.0 ± 23.2
5	Green ambarella	GA	*Spondias dulcis*	719.9 ± 27.7	1055.0 ± 19.5
6	Green mangoes	GM	*Mangifera mekongensis*	2071.8 ± 21.4	709.6 ± 15.3
7	Green guavas	GG	*Psidium guajava*	8144.0 ± 504.3	2108.0 ± 23.8
8	Coriander leaves	CL	*Coriandrum sativum* L.	977.7 ± 19.5	2670.0 ± 72.9
9	Lemongrass leaves	LGL	*Cymbopogon winterianus*	1030.9 ± 63.4	2147.3 ± 11.5
10	Basil leaves	BL	*Ocimum basilicum*	1369.3 ± 60.5	685.7 ± 16.5
11	Lemon leaves	LL	*Citrus aurantifolia*	1549.9 ± 19.7	52009 ± 95.2
12	Elsholtzia leaves	EL	*Elsholtzia cristata*	2091.4 ± 37.2	3642.7 ± 10.3
13	Tungho leaves	TL	*Chrysanthemum coronarium* L.	2711.2 ± 59.3	2164.3 ± 10.0
14	Green tea leaves	GTL	*Camellia sinensis*	16512.3 ± 136.7	1835.3 ± 15.4
15	Buffalo spinach leaves	BSL	*Enydra fluctuans* Lour.	6435.4 ± 11.8	2693.3 ± 37.5

Results and discussions

In Table 1, the TPC of extracts from various plants was shown in the descending order as following: GTL > GG > BSL >TL > ONi > EL > GM > LL > BL > LGL > CL > GA > TR > GR > GLR. From these orders, the extract of green tea leaves is the highest in total phenolic content (16512.3 mgGAE/100g). Moreover, the TPC of green tea leaf extract is 37.3 times higher than that of galangal roots – the lowest in TPC ones. Microwave has more efficiency to extract polyphenols from green tea leaves than traditional extraction methods (solvent extraction). This has been demonstrated through comparison with the study of Pham et al. (2007) conducting the experiments to extract polyphenols from Vietnam's green tea as similarly as the raw materials in our study by using the liquid-solid extraction method were recorded that TPC of 15016 GAE/100g. In order to explain to high efficiency in phenolic extraction, İnce et al. (2013) suggested that microwaves enhance the internal pressure of solid media; as a consequently, phenolic extraction yield will be increased. According to Milan et al. (2011) the TPCs

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and antioxidant activities of green tea extracts was ranged from 1602 to 23368 mgGAE/100g and 14.5 ppm. In addition, the higher IC50 value was, the lower antioxidant capacity archived. The TPC values in our study are similar to those reported, but IC_{50} values are remarkably lower than those. This shows that microwave assisted extraction can be released more polyphenols with high antioxidant activity from green tea leaves such as flavonols, flavandiols, flavonoid (up to 30%), (-)-epicatechin-3-gallate, (-)-epigallocatechin, (-)-epigallocatechin-3-gallate, (-)-epicatechin, and (+)-catechin (Nooman, 2008).

In our study, TPC of galangal roots was 442.6 mgGAE/100g with IC50 value of 3554.9 ppb. These results are significantly different with the result of TPC (2678.85 mg/100g) were reported by Juntachote et al. (2006) when they optimized the conditions for extracting the polyphenols from this material. Moreover, Mahae and Chaiseri (2009) noted that IC50 values of galangal ethanolic extract were 10660 ppb corresponding to TPC of 3149 mgGAE/100g. Interestingly, our results were in reversely with that found by Mahae and Chaiseri (2009) and Juntachote et al. (2006) who noted that the solvent extraction methods could be released more polyphenols due to longer treatment time (90 min), but IC50 value might be decreased due to degradation of these compounds in longer duration.

When comparison turmeric and ginger extracts, both TPC and antioxidant capacity of turmeric were higher than those of ginger extracts. There is some reasons to clear this phenomenon, but the chief ones may be in the different of bio-active ingredients presented in each material. Three main pigments including curcumin 1,7-bis (4-hydroxy-3-methoxylfenil)-1,6-heptadiene-3,5-dione), demethoxyl-curcumin and bis demethoxycurcumin contributed to high antioxidant activities for turmeric roots, meanwhile, major components of ginger are 6-gingerol, 6-shogaol, 8-gingerol and 10-gingerol which determine strong antioxidant activity for this material (Maizura, 2011). Moreover, Maizura (2011) noted that TPC of ginger root extract was 101.56 mgGAE/100g, while this value of turmeric root was 67.89 mgGAE/100g. These values are lower than those findings in our study.

Guava leaf extract also contents a large amount of polyphenols with 18.4 higher than that of galangal roots. Qian and Nihorimbere (2004) mentioned that *Psidium guajava* Linn is a member of the *Myrtaceae* family has been use as a tea for improving human health. In addition, Qian and Nihorimbere (2004) also recorded that TPC of 575.3 mg GAE/g for ethanol guava leaf extracts. Moreover, three flavonoids (quercetin, avicularin, and guaijaverin) present in this leave also introduced because they are responsible for high antioxidant activity of guava leaf extracts. Furthermore, Ling and Palanisamy (2012) extracted polyphenols from these materials also announced that IC50 values of ethanolic extracts and aqueous extracts were 180 ppb and 220 ppb, respectively. Even though the TPC of guava extracts in our study were significantly higher than that showed by Qian and Nihorimbere (2004), the guava extract obtained to microwave assisted extraction in this study have lower in antioxidant capacity than that mentioned by Ling and Palanisamy (2012).

IC50 values showed the anti-oxidant capacity of extract based on the reduction reaction between polyphenols with DPPH free radicals. In addition, the higher IC50 values have, the lower anti-oxidant capacity occurs. It can be deduced from results illustrated in Table 1 that lemon leaf extract possessed low antioxidant capacity due to high in IC50 value (52009 ± 95.2 ppb). On contrary, the basil leaf extract is the highest in antioxidant capacity because of its low IC50 value

(685.7 ± 16.5 ppb). The antioxidant capacity of basil leaf extract is 75.8 times higher than that of lemon leaf extract.

In the study reported by Hinneburg et al. (2006), the TPCs of basil, ginger and cumin when applying hydrodistilled extracts to obtain these compounds were 147; 23.5 and 37.4 (mg GA/g), respectively. Moreover, antioxidant capacity of basil was higher than that of ginger. The similar trend is recorded in our study. Phenolics are secondary metabolites characterize by the presence of several phenol groups (Song et al., 2010). Most of them can be donated a hydrogen atom or an electron and chelated metal ions in aqueous solutions (Song et al., 2010). Some benefits of phenolics to human health such as antitumor, antimutagenic and antibacterial properties are reported by many scientists (Song et al., 2010).

The group of plants have significantly high antioxidant capacity belonged to some ones such as green mango, green ambarella, turmeric roots, onion and green tea leaves with IC_{50} values were not exceeded 2000 ppb. Palmeira et al. (2012) reported that mango peels composed approximately fifteen phenolic compounds including flavonoids and xanthones.

Accoding Ishak et al. (2005), the ambarella belongs to Anacardiaceae family which is abundant in polyphenols. In addition, ambarella derived from Indo-Malaysian region and green fruits use for salads, curries, pickles and juices, but ripe fruits apply to jams, jellies, juices and canned products. Moreover, this fruits are considered as a natural source of vitamin C (36 mg/100g) and iron (0.3 mg/100g). Furthermore, their young leaves can be eaten raw or steamed as a vegetable with salted fish. All parts of this plant (fruits, leaves and barks) have been reported to contain necessary substances for treatment some medical related issues such as sores, wounds, burns and diarrhea (Janick and Robert, 2008).

Onion extracts have high polyphenol content and antioxidant activity due to the present of quercetin di- and triglycosides: 3,4´-O-β-D-diglucoside, 7,4´-O-β-D-diglucoside, 3,7-O-β-D-diglucoside, 3-O-sophoroside-7-O-β-D-glucuronide, 3,7,4´-O-β-D-triglucoside and rutin and Quercetin-monoglycosides spiraeoside (4´-O-β-D-glucoside), 3-O-β-D-glucoside, 3´-O-β-D-glucoside, and 7-O-β-D-glucoside (Lachman et al., 2003). In our study, the total phenolic content and antioxidant capacity of onion extract are 37.8 and 96.5% higher than those of lemon leaf extracts. These results show that onion is suitable for extracting by combining microwave and solvent extraction technique.

Al-Juhaimi and Ghafoor (2011) recorded that aqueous extract of coriander contained 1.12 mg GAE/100g belonging to family Apiaceae and exhibiting significantly antioxidant capacity. These result quietly different with our findings. The reasons for this difference could be the interaction of microwave with solvent molecules causes an abrupt increase in temperature and internal pressure inside the plant which facilitates the subsequent rupture of cellular wall and the release of active compounds into the solvent (Rafiee et al., 2011).

Conclusions

All plants were tested in this study had high total phenolic content and antioxidant activity (except lemon leaf extracts). This shows the ability to use these plants as natural sources of antioxidants to prevent the rancidity of fat and oil products and to suppress the development of spoilage microorganisms in foods. Green tea leaves, green guavas and buffalo spinach leaves are dominated in total phenolic content and antioxidant capacity while lemon leaf extracts are the lowest in both of them.

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