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Short Communication

Total phenolic content and antioxidant activities of edible flower tea products from Thailand

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Abstract

Tea is one of the most widely consumed beverages all over the world due to its beneficial health effects and special flavor and taste. *Tagetes erecta, Telosma minor, Ixora coccinea, Nelumbo nucifera, Antigonon leptopus, Hibiscus rosa-sinensis, Bougainvillea glabra* and *Senna siamea* are used as traditional edible and medicinal materials in Thailand. In this study, the total phenolic content and antioxidant capacities of these edible flower tea drinks were investigated. Each categories of tea were brewed at 90, 95 and 100 degrees Celsius for 3, 5 and 10 minutes to investigate the total phenolic content and antioxidant capacities at different brewing temperature conditions and times. The total phenolic content (TPC) was estimated as gallic acid equivalents by the Folin–Ciocalteu reagent method. The antioxidant activity was measured by ferric-reducing antioxidant power (FRAP). Results showed that tea drink of Tagetes erecta flowers brewed at 100 degrees Celsius for 3 minutes contained the highest level of total phenolic content, 35.446 (mg GAE/g DW). However, Tagetes erecta tea drinks brewed at 95 degrees Celsius for 5 minutes exhibited the highest total reducing capacity (Ferric Reducing Antioxidant Power, FRAP assay; 36.143 µmol $FeSO_4$/g DW). This study has provided useful information for further research in edible flower tea products from Thailand.

Introduction

Flower is an important part of plant containing natural antioxidants such as phenolic acids, flavonoids, anthocyanin and many other phenolic compounds (Kaur *et al*., 2006). Edible flowers have been traditionally used in cooking in various cultures as a garnish or ingredients in salads, soups, entrees, desserts, and drinks (Barash, 1997). In Thailand, many flowers have been used as food while some have medicinal properties and nutritional value (Wongwattanasathien *et al*., 2010). Edible flowers are a valuable source of chemical compounds showing antioxidant activities. Phenolic compounds are a substantial and diverse group of phytochemicals containing of more than 10,000 compounds (Haslam, 1998). Phenolic compounds are responsible for antioxidant activities associated with their ability to scavenge free radicals, break radical chain reactions and chelate metals (Shahidi and Naczk, 2004). In addition, phenolic compounds have been report to correlate with a reduced risk of cardiovascular disease and cancers (Huang *et al*., 2010). Tea is one of the most widely consumed beverages worldwide. Antioxidant activity of tea has been broadly studied; however, the study on antioxidant activity of edible flower tea has been rarely reported. Twelve rose cultivars were selected to assay for antioxidant activity, total phenols, and total anthocyanins contents. The results of this study showed that rose petal tea were rich in total phenols content and exhibited antioxidant activity (Vinokur *et al*., 2006). A massive number of flowers are consumed in Thailand such as Puangchompoo *(Antigonon leptopus)*, Fueangfa *(Bougainvillea hybrida)*, Khee lek *(Cassia siamea)*, marigolds *(Tagetes erecta)*, Bua Luang *(Nelumbo nucifera)*, Kajorn *(Telosma minor)*, Chaba *(Malvaviscus arboreus)* and Kem *(Ixora chinensis)* were used in salad, light curry or are used as vegetables. Therefore, the objectives of this study were to investigate the total phenolic content and antioxidant capacities of these edible flower tea drinks.

Materials and Methods

Plant materials

Eight types of Thai cultivate edible flowers (Table 1) were studied, namely, Puangchompoo *(Antigonon leptopus)*, Fueangfa *(Bougainvillea hybrida)*, Khee

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Table 1. Biological activities literature of the eight edible flowers

Scientific name	Thai name	Common name	Activities
Antigonon leptopus	Puangchompoo	Coral vine	Anti-thrombin, analgesic, antiinflammatory, anti-diabetic and lipid peroxidation inhibitory
Bougainvillea hybrid	Fueangfa	Paper flower	Antidiabetic and anti-inflammatory
Cassia siamea	Khee lek	Siamese senna	Treatment of fever, skin disease, constipation, diabetes, hypertension and insomnia
Malvaviscus arboreus	Chaba	Queen of tropic flower	Antifungal activity
Ixora chinensis	Kem	West Indian jasmine	Hepatoprotective, Chemoprotective, antimicrobial, anti-oxidant, antinociceptive, anti-mitotic. anti-inflammatory activities
Nelumbo nucifera	Bua luang	Sacred lotus	Anti-obesity, anti-oxidant, anti-diabetic activity, anti-inflammatory, antipyretic activity and antifungal activity
Tagetes erecta	Daao rueang	Marigold	For skin complaints, wounds and burns, conjunctivitis and poor eyesight, menstrual regularities, inflammation, antiviral
Telosma minor	Kajorn	Cowslip creeper	Antimicrobial activity

From: Kaisoon *et al*., 2011; Kaisoon *et al*., 2012.

lek *(Cassia siamea)*, Daao rueang *(Tagetes erecta)*, Bua Luang *(Nelumbo nucifera)*, Kajorn *(Telosma minor)*, Chaba *(Malvaviscus arboreus)* and Kem *(Ixora chinensis)*. The fresh edible flowers were collected from Central Thailand. The samples were cleaned by using distilled water; the petals were separated and kept at room temperature to drain. Afterwards, the petals were dried under hot air at 60°C. The dry petals were grinded and stored at cool dry place until analyzed.

Brewing procedure

The dry plant materials were steeped in 10 ml boiling water (10 ml water per 0.25 g dry petal plant material) and infused in a water bath at 90°C, 95°C and 100°C. The infusion time varied from 3, 5 and 10 min. The tubes supernatant was separated by filtration through coffee filter paper (Boncafe' Thailand Ltd., Thailand). The filtered supernatant was used for the determination of total phenolic contents and antioxidant activity. Each sample was prepared in triplicate.

Determination of total phenolic contents

The amount of total phenolic content (TPC) was investigated using the Folin-Ciocalteau assay (Djeridane *et al*., 2006). Briefly, 0.25 ml of each edible flower tea drinks was taken into a test tube. To this solution, 2.5 ml of Folin-Ciocalteu reagent (10 x dilutions) was added and the tube was shaken thoroughly. After 5 min, 2 ml of sodium carbonate solution (7.5%w/v) was added to the mixture. The mixture was incubated at 50°C for 5 minutes with intermittent shaking. The absorbance was measured at 760 nm using spectrophotometer. The total phenolic content was calculated and expressed as gallic acid equivalents per gram of dry weight (mg GAE/g DW) based on a gallic acid standard curve.

Determination of ferric reducing antioxidant power

The total reducing capacity of each edible flower tea drinks was determined using FRAP assay with some modifications (Benzie and Strain, 1996). The FRAP reagent was initially prepared including 300 mM acetate buffer, pH 3.6, 10 mM TPTZ solution in 40 mM HCl and 20 mM $FeCl_3$. $6H_2O$ solution. The fresh working solution was warmed at 37°C prior using. Flower tea drinks (20 µl) were mixed with 180 µl of the FRAP solution and incubated for 10 min. The absorbance was measured at 593 nm using a spectrophotometer. The FRAP values were calculated by standard curves prepared with known concentrations of $FeSO_4$ and expressed as µmol $FeSO_4$ per gram of dry weight. The reducing capacity of the samples was expressed as µM of iron (Fe, II) per gram of dry weight (µM Fe^{2+}/g DW) based on an iron (II) sulfate standard ($FeSO_4$) curve.

Statistical analysis

All experiments were carried out in triplicate. Analysis of variance and Duncan's multiple-range tests were used to statistically analyze all results. Differences between means were considered significant when $p < 0.05$.

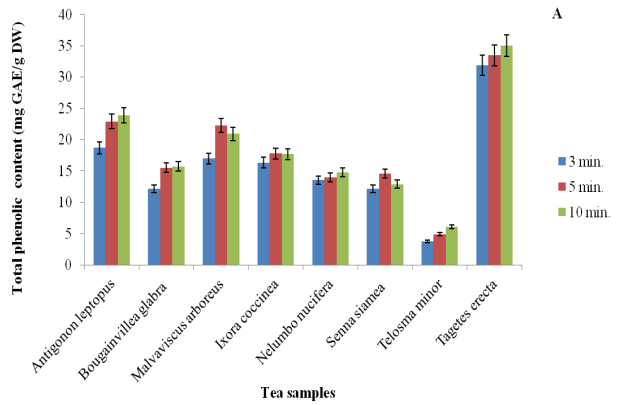
Results and Discussion

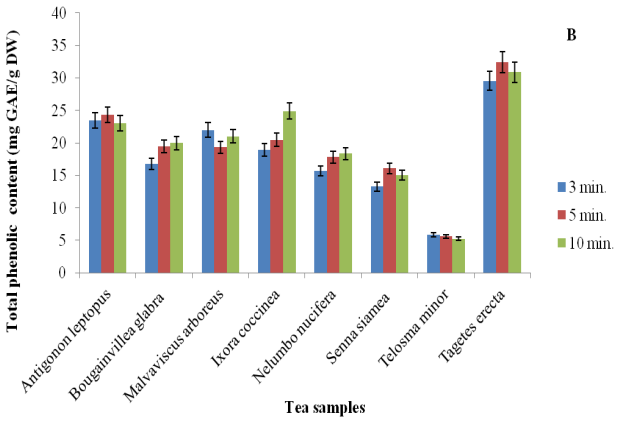
Determination of total phenolic content (TPC)

Phenolic compounds are one of the most effective antioxidative constituents that contribute to the antioxidant activity (Velioglu *et al*., 1998) and play a role in free radical scavenging capacities (Govindarajan *et al*., 2007). Total phenolic content (TPC) of edible eight flower tea drinks was determined by the Folin-Ciocalteu assay. According to Figure 1, the highest TPC was obtained from Daao rueang *(Tagetes erecta)* tea at all infusion temperature (29.552-35.446 mg GAE/g DW). The results showed that tea drink of Tagetes erecta flowers brewed at 100°C for 3 minutes contained the highest level of total phenol content at 35.446 mg GAE/g DW. Interestingly, Antigonon leptopus, Malvaviscus arboreus and Ixora coccinea exhibited high level of TPC at all infusion temperature. Among all plant samples, *Telosma minor* showed the lowest level of TPC. Our study reported that infusion temperature at 100°C for 3-5 minutes exhibited the high level of TPC in all edible flower tea drinks. Ni and colleagues (2003) reported that soaking tea at higher temperature increased the extraction yield of tea polysaccharides and other soluble solids. Su and colleagues (2006) reported that infusion conditions had major effect on antioxidant potentials and higher temperature (100°C) for longer time (10 minutes) decreased polyphenol compounds (Su *et al*., 2007).

Determination of the reducing power of edible flower tea drinks

The FRAP assay is based on the measurement of the ability of the substance to reduce Fe^{3+} to Fe^{2+} resulting in the change of color from yellow to blue colored solution of Fe^{2+}- TPTZ complex (Fe^{2+} tripyridyltriazine) which has a high absorbance at 593 nm. The FRAP assay provides a reliable method to study the antioxidant activity. Among eight edible flowers, tea drink of Tagetes erecta flowers revealed the highest reducing power at all brewing duration and brewing temperature with the FRAP value at 26.303 - 36.143 µM Fe^{2+}/g DW (Figure 2). The result showed that Tagetes erecta tea had the highest FRAP value of 36.143 µM Fe^{2+}/g DW at brewing temperature at 95°C for 5 minutes. Our study also investigated that *Antigonon leptopus, Malvaviscus arboreus* and *Ixora coccinea* tea exhibited the high FRAP value. Generally, the reducing properties are associated with the presence of compounds, which exert their action by breaking the free radical chain through donating a hydrogen atom (Duh *et al*., 1999; Gordon, 1990). Our study suggests that brewing tea





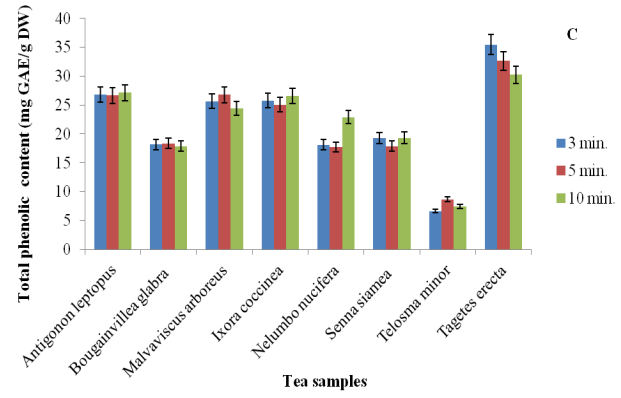
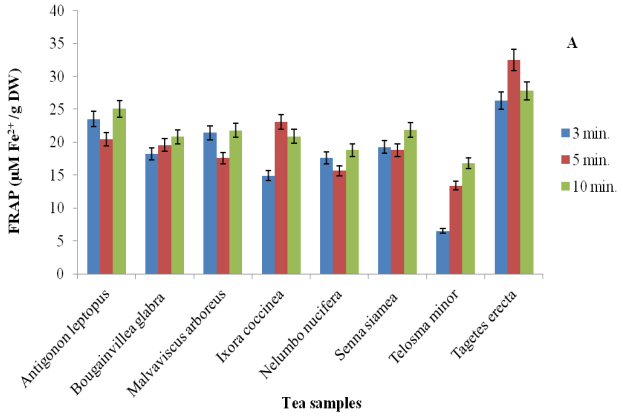
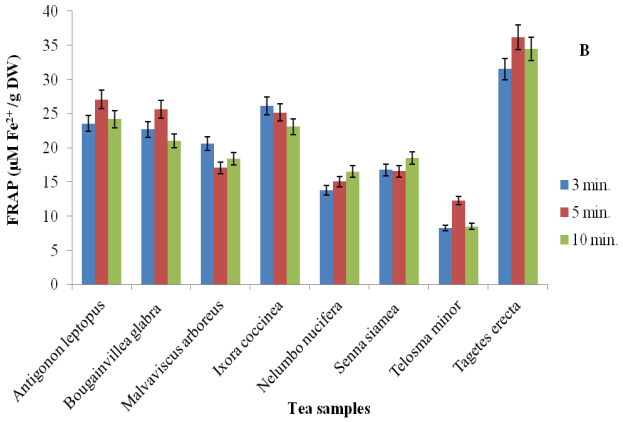


Figure 1. Total phenolic content of the eight flower tea drink.
Where; infusion temperature at 90ºC (A), 95ºC (B) and 100ºC (C).





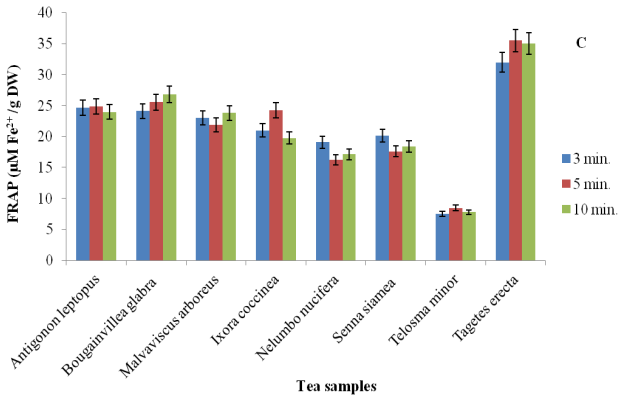


Figure 2. The reducing power of the eight flower tea drinks
Where; infusion temperature at 90ºC (A), 95ºC (B) and 100ºC (C)

at 95°C -100°C for 3-5 minutes produced high in polyphenols.

Conclusion

Tagetes erecta tea revealed the highest level of total phenol content and reducing properties. The results indicated that different amounts of tea polyphenols obtained at different brewing temperatures and duration. This study suggests that plants with higher total phenolic contents exhibit higher reducing power. The future study will determine total flavonoid content (TFC) and antioxidant properties using various methods consisting of DPPH radical scavenging activity, ABTS radical cation decolorization activity and inhibition of lipid peroxidation assay.

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