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Torch Ginger (*Etlingera elatior* (Jack) R.M. Smith.) Tea and the Effects of Brewing Time on Color, Volatile Compounds, Chemical Compositions and Sensory Quality

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Abstract

The torch ginger tea made from flower of *Etlingera elatior* (Jack) R.M. Smith. It is a type of herbal tea (tisanes) with health benefits. The composition of volatile aroma compounds is one of the factors which induce relaxation and charming scent. The purpose of this study was to profile volatile compounds of the torch ginger tea and quality on physical, chemical, and sensory properties of torch ginger tea. The torch ginger tea infusion was prepared by adding 2 and 5 g of torch ginger tea into 100 ml of hot water (95°C) infused for 5 and 10 min and is effected by quantity and brewing time. Results showed that volatile compounds of the dried petal of the torch ginger had the highest abundance that included α-pinene, 1- dodecanol and dodecanal, respectively. The odor description were fresh, sweet, pine earthy and woody. Prolonged brewing time and enrichment quantity of the dried petal of the torch ginger decreased L*(lightness) values but increased positive a* (red) and positive b*(yellow) significantly ($p < 0.05$). 5 g torch ginger with 10 min brewing time had the highest chemical content consisting of the total phenolic content (206.42 mg GAE/100 g dry weight), the total anthocyanin content (0.887 mg/100 g dry weight), the ascorbic acid (0.602 mg/100 g dry weight) and DPPH (49.38 % inhibition) were significantly ($p < 0.05$). However, 2 g torch ginger with 10 min brewing time had the chemical content (the total phenolic, the total anthocyanin, the ascorbic acid and DPPH) as well as with the 5 g torch ginger tea with brewing time at 5 min. The sensory properties showed 5 g torch ginger tea with 10 min brewing time had high scores for color, flavor, taste and over all acceptance. Finally, 5 g torch ginger and 10 min brewing time was recommended as the best condition.

Introduction

The World Health Organization (WHO) declared COVID-19 a global pandemic in March 2020. After two years, many countries were able to control the spread of COVID-19 through various measures and medical care. The COVID-19 pandemic had a great effect on people's lifestyle having to lockdown by staying and working

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from home. This situation of the lockdown was stressful for all people, effecting work routines, sociability, and transforming eating habits. The trends in coffee and tea consumption during the COVID-19 pandemic have shown that tea consumption increased to support health. (Castellana et al., 2021). Popular teas are made from the leaves of the *Camellia senenisis* plant such as green tea, oolong tea and black tea. However, Tisanes or Herbal teas do not originate from the *Camellia Sinensis* plant but are made from combinations of dried leaves, seeds, grasses, nuts, barks, fruits, flowers, or other botanical elements (Ravikumar, 2014). Tisanes are sources of natural bioactive compounds such as carotenoids, phenolic acids, flavonoids, coumarins, alkaloids, polyacetylenes, saponins and terpenoids, including the antioxidant that enhance the overall health (Chandrasekara & Shahidi, 2018). Tisanes has been used for its medicinal properties as method to help induce relaxation, digestive problems or curb stomachaches and also to boost the immune system. The famous herbal teas are chamomile tea, ginseng tea, peppermint tea, cinnamon tea, ginger tea (Ravikumar, 2014; Chandrasekara & Shahidi, 2018).

The torch ginger tea is made from the flower of *Etlingera elatior.* (Jack) R.M. Smith. which is kinds of herbal teas refer to Notification of the Ministry of Public Health (No.426) (2021), Thailand, Issued by virtue of Food Act, Re: Tea Infusion. *E. elatior* or the torch ginger is a plant belonging to Zingiberaceae family and recognized for aromatic plants and as a herbal plant native to South-Asian which is found in several countries such as Thailand, Malaysia and Indonesia. Thailand. It is known as Dalaa or kaalaa or kantan in Thailand, Malaysia and Indonesia Kincung. (Susanti et al., 2013). The full bloom of torch ginger may contain up to 20-25 layers (Fig. 1).

Fig. 1 The characteristics of *E. elatior* flower

The torch ginger which is widely used as a cooking herb or eaten raw for its medicinal properties and used as an ingredient for traditional food (Lachumy et al., 2010). The torch ginger flower is one of the Thai ingredients in a traditional dish called "Kao Yam Budu". The consumption of *E. elatior* in food is indicated to have high nutrients and phytochemicals such as fat (0.37%), carbohydrate (2.46%), fiber (0.96%), protein (0.44%), vitamin C content (1.05 mg/100 g), calcium (100 mg/100 g), potassium (194 mg/100 g), total phenolic (2.29 mg GAE/g extracts), total flavonoids (42.50 mg RE/g extracts), DPPH (68.70% inhibition) (Rachkeeree et al., 2018). Prior studies have reported that *E. elatior* were found to have pharmacological activities including anti-microbial, anti-hyperglycemic, anti-hyperuricemic, anti-tumor, anti-inflammatory, anti-larvae, anti-oxidant activity (Srey et al., 2014; Dewi et al., 2016; Chan et al., 2010; Aldi et al., 2020). Besides, the torch ginger inflorescence has been used as an ingredient in cosmetic for skin whitening, anti-aging, wound healing, and lipstick (Nithitanakool et al., 2014; Adliani et al., 2012; Juwita et al, 2018). In addition, tea aroma is determined by the nature of the plant that the composition of volatile aroma compounds is one of the factors that induce relaxation. The most abundant compounds in the opened torch ginger inflorescence included α-pinene, decanal and 1-dodecanol (Zoghbi & Andrade, 2005; Anzian et al., 2017). The fresh torch ginger flower was extracted with 95% ethanol and their odor description were considered fatty, woody and sweet, the most volatile compounds were dodecanal, α-humulene, decanal, β-cayophyllene and α-pinene (Kaprasob et al., 2016). Many factors are considered in preparation of good flavor tea and aroma tea infusion such as temperature of water, and quantification of tea including brewing time. The brewing time effects the diffusion of phytochemicals into the water. The report showed that prolonged brewing time increased the bioactive compounds and antioxidant capacity (Burilllo et al., 2018). The herbal tea and green tea products analyzed the polyphenols and antioxidant activity and reported that increasing volume of water used for infusion had an effect to decreasing of the phenolic compound. The concentrated tea infusion was recommended by consumers for higher antioxidant, resulting in enhancement of tea astringent (Abdullah & Mazlan, 2020). The previous report found that green teas brewed with hot water (100°C) at 10 min and oolong teas brewed with hot water (100°C) at 5 min had the best condition

for higher antioxidant (Kowalska et al., 2021). The optimum temperature and time for brewing kenaf leaves tea (*Hibiscus cannabinus* L.) was 80°C at 10 min extracting the highest antioxidants properties (Chong & Nyam, 2022). Thai herbal teas containing 2 g of each sachet for commercial use were studied for the antioxidant properties. The result showed that banaba (*Lagerstroemia speciose* L.Pers.) had the highest antioxidant properties (Chan et al., 2012). However, there is limited research on the quality of the torch ginger tea. The torch ginger tea could be used as an alternative source of phytochemical and aromatic that is beneficial for health. Thus, the objective of this study were to profile volatile compounds, quality on physical, chemical, and sensory properties of torch ginger tea as affected by quantity and brewing time.

Materials and methods

1. Plant Materials Preparation

The torch ginger flower was provided from Trang Horticultural Research Center, Thailand. The fresh flower was selected at full bloom with no physical defects, washed with water, pulled and dried the petals. The petal of the torch ginger was cut from the inflorescences, washed with water, and dried by hot air oven at 40°C for 4 hrs until moisture content reached below 7%. This drying temperature at 40°C was modified from Taufik et al. (2016). The dried petal of the torch ginger was blended using a commercial kitchen blender (Model BL 335, Waring, Selang, Thailand) then contained in a sachet (Fig. 2).

2. Analysis of Volatile Compounds

Gas chromatography- mass spectrometry (GC-MS) analysis as described by Wijekoon et al. (2013) was performed from the dried petal of the torch ginger (10 g) for analyzing volatile compound. The GC system used a mass selective detector (Agilent 7890B, USA), equipped with HP-5 (30 m × 0.25 mm, 0.25 μm film thickness). Helium was used as the carrier gas, injector was 250°C, split flow was 25:1, the oven temperature was maintained at 250°C for 10 min (a rate of 5°C /min), solvent was delayed 1 min, ion source and transfer temperature was 250°C and fragments from 22 to 600 Da.

3. Effect of quantity and brewing time of torch ginger tea

3.1 Physical properties

Reflected color measurement of the torch ginger tea infusion was prepared by adding 5 and 10 g of torch ginger tea into 100 mL of hot water (95°C) infused for 5 and 10 min and cooled to 25°C. Then, each torch ginger tea infusion was measured by Colorimeter (Minalta CR-400 Series, Konica Minolta, lnc., Japan). The sample in combination with the sample holder CR-A505 and specimen holder CM-A96 and a glass cell 10 mm CM-A98.This method was determined by Guzel-Seydim et al. (2021) by The CIELAB L* a* b* system. Results were reported as an average of individual values as L* (lightness), a* (+a =red, -a = green) and b*(+b = yellow, -b = blue).

3.2 Chemical properties

3.2.1 Determination of total phenolic content (TPC)

The total phenolic content in the torch ginger tea infusions were determined by the Folin-Ciocalteu's reagent this method was modified from Dian-Nashiela et al. (2016). The sample (0.1 mL) was mixed with 0.5 mL of 1 mol/l of Folin-Ciocalteu reagent and incubated at room temperature for 3 min. Then, 1.5 ml of 7.5% ($NaCO_3$) sodium carbonate and 7.9 ml distilled water were added into a test tube. The solution was mixed thoroughly and left in the dark for 2 h. The mixture was measured for absorbance at 765 nm by UV-Vis Spectrophotometer (Shimadzu, UV mini-1240, japan). The total phenolic content calculated as milligrams gallic acid equivalent (mg GAE/100g) by using a gallic acid calibration curve.

3.2.2 Determination of total anthocyanin content

Total anthocyanin content was determined using the pH difference method which was modified from Giusti & Wrolstad (2001) and Wijekoon et al. (2011). The torch ginger tea infusions 0.5 ml of the tea was mixed with 3.5 mL of 0.025 M potassium chloride buffer at pH 1. The solution was incubated at room temperature for 15 min. The absorbance was measured at wavelength of 510 and 700 nm by UV-Vis Spectrophotometer. Distilled water was used blank and according to the same method, the tea infusions was mixed with 0.025 M sodium acetate buffer at pH 4.5. The solution was left at room temperature for 15 min. The absorbance at 510 and 700 nm was measured by UV-Vis Spectrophotometer. The total anthocyanin content (mg/100 g dry weight) was calculated following equation:

$$\text{Total anthocyanin content} = \frac{A \times MW \times DF \times 1{,}000}{\epsilon \times l}$$

$A = (A_{510} - A_{700})_{pH1.0} - (A_{510} - A_{700})_{pH4.5}$
MW = the molecular weight of cyanidin-3-glucoside (449.2 g/mol)
DF = the dilution factor
ϵ = the molar extinction coefficient (26,900 L x cm^{-1} x mol^{-1})
l = the cell length

3.2.3 Determination of ascorbic acid or vitamin C content

Determination of ascorbic acid or vitamin C content was modified from Roe et al. (1948) and Sukporn et al. (2019). Briefly, 1 mL of the tea infusions was mixed thoroughly with 10 mL 5% metaphosphoric acid solution. The absorbance was measured at 540 nm by UV-Vis Spectrophotometer with a blank of distilled water. The ascorbic acid was used as standard. The experiment was reported equivalents mg/100g dry weight.

3.2.4 Determination of DPPH radical scavenging assay

The capacity of the torch ginger tea infusions on reduction of free radical of 2,2-diphenyl-1-picrylhydrazyl (DPPH) was determined by Wijekoon et al. (2011). Then, the tea infusions 0.1 mL was mixed with 3.9 mL of methanolic solution of DPPH radical (25 mg/L). The solution was mixed thoroughly and incubated in the dark at room temperature for 30 min. The absorbance was measured at wavelength of 515 nm by UV-Vis Spectrophotometer. The percentage inhibition of DPPH was calculated by the following equation:

$$\text{Percentage inhibition of DPPH} = \frac{A_{control} - A_{sample}}{A_{control}} \times 100$$

$A_{control}$ = the absorbance of the DPPH solution without the tea infusions
A_{sample} = the absorbance of the sample with DPPH solution

3.3 Sensory properties

The acceptance of the torch ginger tea was determined with a 9-point hedonic scale. Fifty untrained panelists evaluated their liking of quality attributes including color, flavor, taste, and overall liking. The 9-point hedonic scale ratings consisted of 9 like extremely, 8 like very much, 7 like moderately, 6 like slightly, 5 neither dislike nor like, 4 dislike, 3 dislike moderately, 2 dislike very much and 1 dislike extremely. The sample of the torch ginger tea was served at 65-70°C. Samples of torch ginger teas were prepared and served for amount of tea and temperature control. Samples of torch ginger tea were prepared with two methods; 2 g and 5 g of torch ginger tea were brewed with 100 mL of hot water for 10 min and 5 min, respectively (Resurreccion, 1998).

4. Statistical Analysis

Factorial in Completely Randomized Design (CRD) was performed to study the effect of quantity and brewing time on the physical and chemical qualities of torch ginger tea. The randomized completely block design (RCBD) was performed to study quality of torch ginger tea on sensory properties. The experiments were done in triplicate. The results were presented as mean values ± standard deviations (S.D.). Analysis of variance (ANOVA) with Duncan's New Multiple's Range Test (DMRT). The differences were determined to be statistically significant at $p < 0.05$.

Fig. 2 The fresh petal of the torch ginger (a), the dried petal of the torch ginger (b) and the torch ginger tea in sachet (c)

Results and discussion

1. Analysis of Volatile Compounds

Result of GC-MS analysis of the torch ginger (*E. elatior*) tea indicated a total of 6 compounds. The highest volatile compounds of the torch ginger tea were α-Pinene, 1-Dodecanol, Dodecanal, respectively. The kind of volatile compound, retention time (RT), percentage composition calculated from percentage area, chemical structure and odor description are presented in Table 1. The torch ginger odor's descriptions were fresh, sweet, pine, earthy and woody. The monoterpene group, α-pinene (54.53% area) were the major component of the torch ginger tea from the dried petal of *E.elatior*. In accordance with Zoghbi & Andrade (2005) and Wijekoon et al. (2011) dodecanol, dedecanal, α-pinene were the major component of the inflorescence oil of *E.elatior* by GC-MS. Kaprasob et al. (2016) reported the highest abundant in fresh *E.elatior* was dodecanal which in this current study the highest abundant in dry *E.elatior* was α-Pinene. Dodecanal which is a type of Aldehyde. The

amount of aldehydes from citrus essential oils was reduced by heat, sunlight, and oxygen during production and storage (Sun et al., 2014). Dodecanal in the torch ginger (*E. elatior*) tea was lower than the fresh torch ginger because the teas were dried from heat. Besides, the torch ginger odor descriptions were fresh, sweet, pine, earthy and woody. According to the results of Kaprasob et al. (2016) fatty, woody and sweet were the odor descriptions in the volatiles of the flower of *E. elatior*.

Table 1 Volatile compounds of the torch ginger (*E. elatior*) tea

Volatile compound	RT	% area	Odor description*
Furfural	3.158	5.39	Almond, bread, caramel, cinnamon, pungent, sweet
α-Pinene	4.836	54.53	Fresh, sweet, pine, earthy, woody
Bicyclo[3.1.0.] hex-2-ene, 4-methylene-1-1 (1-methylethyl)-	5.262	5.96	-
Dodecanal	16.827	13.29	Earthy, waxy, fatty, coconut like
Caryophllene	17.165	3.29	Spicy, woody, terpenic
1-Dodecanol	18.417	17.32	Earthy, soapy, waxy fatty, honey, coconut

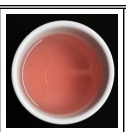
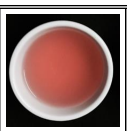
Remark: * http://www.odour.org.uk/, http://www.flavornet.org/flavornet.html

2. Quality of Torch Ginger (*Etlingera elatior*) Tea

2.1. Effect of quantity and brewing time of torch ginger tea on physical properties

Color parameter of the torch ginger (*E.elatior*) tea infusions, lightness (L* values) were significantly decreased ($p < 0.05$) with enrichment quantity of tea and brewing time.(Table 2) The result was in agreement with the L* value of blueberry juices after hot water bath treatment (5 min) were darker than blueberry juices steam treatment (3 min) (Zhang et al., 2019). The 5 g of torch ginger with brewing time at 10 min showed the positive b*(yellow) values and positive a* (red) values increased significantly ($p < 0.05$) and the positive a* (red) values related to the increasing of the total anthocyanin content. In accordance with the results of Zhang et al. (2019) showing the total anthocyanin content of blueberry juice with results showing a significant ($p<0.05$) increase with longer time of steam treatment occurred from 0 to 3 min.

Table 2 Color of the torch ginger (*E.elatior*) tea infusions

Tea infusion				
Color	2 g 5 min	2 g 10 min	5 g 5 min	5 g 10 min
L*	41.87 ± 0.10^{a}	40.61 ± 0.04^{b}	40.84 ± 0.09^{b}	29.21 ± 0.17^{c}
a*	27.05 ± 1.24^{c}	29.35 ± 0.10^{b}	30.48 ± 0.10^{b}	33.60 ± 1.20^{a}
b*	15.00 ± 0.06^{c}	17.58 ± 0.40^{b}	17.23 ± 0.04^{b}	19.94 ± 0.18^{a}

Remark: The results were expressed as average ± standard deviation. The difference letters among quantity and brewing time represented significant difference at $p < 0.05$

2.2 Effect of quantity and brewing time of torch ginger tea on chemical properties

2.2.1 Determination of total phenolic content (TPC)

In this study the total phenolic content of torch ginger tea infusions found in the range of 131.11-206.42 mg GAE/100 g dry weight and showing significant difference ($p<0.05$) among quantity and brewing time of torch ginger tea. The maximum of total phenolic content was recorded in 5 g of torch ginger with brewing time at 10 min and the minimum content was in 2 g of torch ginger with brewing time at 5 minutes. Prior studies reported higher amounts of the total phenolic content at 356 mg GAE/100 g from dried torch ginger flower extracts (Anzian et al., 2017). In this study, the total phenolic content was analyzed from torch ginger tea infusions where the dried torch ginger flower was brewed with hot water, causing this result to be lower than the previous studies where the total phenolic content was analyzed from dried torch ginger flower extracts. The results showed that quantity of torch ginger tea and brewing time significantly affected the total phenolic content ($p<0.05$).

2.2.2 Determination of total anthocyanin content

The total anthocyanin content of torch ginger tea infusion was found in the range of 0.462-0.887 mg/100 g dry weight and showing significant difference ($p<0.05$) among quantity and brewing time of torch ginger tea. The maximum of the total anthocyanin content was recorded in 5 g of torch ginger with brewing time at 10 min and the minimum content was in 2 g of torch ginger with brewing time at 5 min. (Table 3) The total anthocyanin content showed the same as the total phenolic content of torch ginger tea infusion. In accordance with the results of Zhang et al (2019), the effect of thermal pretreatment processing on juice, the total phenolic content and the total anthocyanin content of blueberry juice results showed significant ($p<0.05$) increases in the total phenolic content and the total anthocyanin content when longer time of steam treatment occurred from 0 to 3 min. For this study, the total anthocyanin content of torch ginger tea infusion was found to be higher when longer brewing time occurred. Similarly, with results of Rossi et al. (2003) and Liu et al. (2016) the extraction of anthocyanin and other phenolic compound and color density of fruit increased by heat pretreatment processing.

2.2.3 Determination of ascorbic acid or vitamin C content

The ascorbic acid content of torch ginger tea infusions was found in the range of 0.380-0.602 mg/100 g dry weight and showing significant difference ($p<0.05$) among quantity and brewing time of torch ginger tea. The maximum of ascorbic acid content was recorded in 5 g of torch ginger with brewing time at 10 min and the minimum content was in 2 g of torch ginger with brewing time at 5 min (Table 3). These values were low when compared with the study of Rachkeeree et al. (2018) when the eight edible flowers (ginger family) from Thailand were analyzed for the nutritional composition and phytochemical properties showing the vitamin C content as 1.05 mg/100 g.The vitamin C content found in the torch ginger was due to the vitamin C being analyzed in the fresh torch ginger flowers. Ascorbic acid has been indicated as sensitive to heat treatment.This was found when the fresh Cara Cara juice showed ascorbic acid as 0.47 mg/ml when heat is transferred to juice then ascorbic acid was lost at 68.09% (Lu et al., 2018). In this study the torch ginger was dried by hot air oven allowing thermal processing conditions to increase the ascorbic acid losses. Nevertheless, the ascorbic acid content of the torch ginger tea increased with longer brewing time. According to the results of Um et al. (2020) the optimum time for ascorbic acid extraction from rugosa rose fruit were 30 min. In addition, the vitamin C is beneficial to human health because it is an antioxidant that prevents humans from oxidative stress (Stevens et al., 2007).

2.2.4 Determination of DPPH radical scavenging assay

Percentage inhibition of DPPH of torch ginger tea infusion was found in the range of 29.94-49.38 and showing significant difference ($p<0.05$) among quantity and brewing time of torch ginger tea. The maximum percentage inhibition of DPPH was recorded in 5 g of torch ginger with brewing time at 10 min and the minimum content was in 2 g of torch ginger with brewing time at 5 min (Table 3). Similarly, with results of Rachkeeree et al. (2018), phytochemical properties of the eight edible flowers (ginger family) from Thailand was study that the percentage inhibition of DPPH of torch ginger flowers was found 68.70. The value of the fresh torch ginger was higher than the dry torch ginger in this study because it was heat sensitive. DPPH or the antioxidant capacity related to the total anthocyanin content and the total phenolic content. In accordance with results of Zhang et al (2019) the antioxidant capacity of blueberry juice was related to the anthocyanin content and the total phenolic content.

Table 3 The effects of quantity and brewing time on chemical properties of torch ginger tea

Chemical properties	Quantity (g) and brewing time (min) of torch ginger tea			
	2 g 5 min	2 g 10 min	5 g 5 min	5 g 10 min
Phenolic (mg GAE/100 g dry weight)	131.11±0.51^{c}	164.73±0.08^{b}	165.48±0.19^{b}	206.42±0.38^{a}
Anthocyanin content (mg/100 g dry weight)	0.462±0.0015^{c}	0.642±0.0013^{b}	0.645±0.0007^{b}	0.887±0.0039^{a}
Total ascorbic acid (mg/100g dry weight)	0.380±0.039^{c}	0.429±0.005^{b}	0.436±0.003^{b}	0.602±0.005^{a}
DPPH (% inhibition)	29.94±0.044^{c}	37.80±0.118^{b}	37.88±0.044^{b}	49.38±0.044^{a}

Remark: The results were expressed as average ± standard deviation. The difference letters among quantity and brewing time represented significant difference at $p < 0.05$

2.3 Effect of quantity and brewing time of torch ginger tea on sensory properties

Sensory evaluation of torch ginger tea infusion were prepared by adding 5 and 10 g of torch ginger tea into 100 mL of hot water (95°C) infused for 5 and 10 min, respectively and was served at 65-70°C. The score of sensory evaluation results indicated the color, flavor, taste, and over all acceptance of 5 grams' torch ginger with brewing time at 10 min and receiving the high sensory value for all attribute (Table 4).

Table 4 The effect of quantity and brewing time of torch ginger tea on sensory attribute

Sensory attribute	Quantity (g) and brewing time (min) of torch ginger tea			
	2 g 5 min	2 g 10 min	5 g 5 min	5 g 10 min
Color	6.80 ± 0.40^{b}	7.00 ± 0.40^{b}	7.04 ± 0.49^{b}	7.14 ± 0.46^{a}
Flavor	6.68 ± 0.47^{b}	6.80 ± 0.53^{ab}	6.86 ± 0.53^{ab}	6.98 ± 0.55^{a}
Taste	6.76 ± 0.43^{b}	6.92 ± 0.49^{ab}	6.94 ± 0.51^{ab}	7.10 ± 0.51^{a}
Over all acceptance	6.78 ± 0.42^{c}	6.98 ± 0.43^{b}	7.00 ± 0.45^{ab}	7.16 ± 0.42^{a}

Remark: The results were expressed as average ± standard deviation. The difference letters among quantity and brewing time represented significant difference at $p < 0.05$

Conclusion

The torch ginger (*E.elatior*) tea revealed the highest volatile compounds were α-Pinene, 1-Dodecanol, Dodecanal, respectively. Their odor description were fresh, sweet, pine, earthy and woody. The quantity and brewing time had an affect on color, chemical properties (the total phenolic content, anthocyanin content, ascorbic acid, DPPH) by 5 g of torch ginger with brewing time at 10 min showing the highest chemical content that is

beneficial for human health. Similarly, as sensory evaluation of 5 g of torch ginger with brewing time at 10 min had the best acceptability for color, flavor, taste and over all acceptance.

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References

Abdullah, S.S.S., & Mazlan, A.N. (2020). Quantification of polyphenols and antioxidant activity in several herbal and green tea products in Malaysia, *Materials Today: Proceedings, 31*(1), A106–A113.

Adliani, N.N., & Purba, D. (2012). Lipstick formulation using natural dye from *Etlingera elatior* (Jack) R.M.Sm. extract. *Journal of Pharmacy and Pharmacology, 1,* 87-94.

Aldi, Y., Husni, E., & Yesika, R. (2020). Activity of Kincung flowers (*Etlingera Elatior* (Jack) R.M.Sm.) on total leukocytes and percentage of leukocytes in allergic male white mice. *Pharmacognosy Journal, 12*(1), 44-51.

Anzian, A.B., Rashidah, S., Saari, N., Sapawi, C.W., & Hussin, A.S.B.M. (2017). Chemical composition and antioxidant activity of torch ginger (Etlingera elatior) flower extract. *Food and Applied Bioscience Journal, 5,* 32-49.

Burillo, S.P., Gimenez, R., Rufian-Henares, J.A., & Pastoriza, S. (2018). Effect of brewing time and temperature on antioxidant capacity and phenols of white tea: Relationship with sensory properties. *Food Chemistry, 248,* 111-118.

Castellana, F., De Nucci, S., De Pergola, G., Di Chito, M., Lisco, G., Triggiani, V., … Zupo, R. (2021). Trends in coffee and tea consumption during the COVID-19 pandemic. *Foods, 2021,* 10, 2458.

Chan, E.W.C., Eng, S.Y., Tan, Y.P., Wong, Z.C., Lye, P.Y., & Tan, L.N. (2012). Antioxidant and sensory properties of Thai herbal tea with emphasis on Tunbergia laurifolia Lindl. *Chiang Mai Journal of Science, 39,* 599–609.

Chan, E.W.C., Lim, Y.Y., & Nor Azah, M.A. (2010). Composition and antibacterial activity of essential oils from leaves of Etlingera species (Zingiberaceae). *International Journal for Advancement of Science & Arts, 1,* 1-12.

Chandrasekara, A., & Shahidi, F. (2018). Herbal beverages: Bioactive compounds and their role in disease risk reduction. *Journal of Traditional and Complementary Medicine, 8,* 451- 458.

Chong, Y.K., & Nyam, K.L. (2022). Effect of brewing time and temperature on the physical properties, antioxidant activities and sensory of the kenaf leaves tea. *The Journal of Food Science and Technology, 59*(2), 510-517.

Dewi, A.R., Nur'aini, I., Bahri, I.S., Afifah, H.N., Fattah, A., & Tunjung, W.A.S. (2016). Antihyperuricemic activity of ginger flower (*Etlingera elatior* Jack.) extract in beef broth-induced hyperuricemic rats (*Rattus norvegicus*). In *AIP Conference Proceedings* (p. 140012). Malasia: AIP Publishing LLC.

Dian-Nashiela, F., Noriham, A., Nooraain, H., & Azizah, A.H. (2016). Antioxidant activity of herbal tea prepared from Cosmos caudatus leaves at different maturity stages, *Malaysian Journal of Analytical Sciences, 20,* 607–617.

Giusti, M.M., & Wrolstad, R.E. (2001). Characterization and measurement of anthocyanins by UV–visible spectroscopy. In Wrolstad, R.E. (Ed.), *Current Protocols in Food Analytical Chemistry Unit F1.2.1-13.* New York: John Wiley and Sons.

Guzel-Seydim, Z.B., Seydim A.C., & Greene, A.K. (2021). Effect of brewing method on quality parameters and antioxidant capacity of black tea. *Functional Food Science, 1*(8), 1-13.

Juwita, T., Puspitasari, I.M., & Levita, J. (2018). Torch ginger (*Etlingera elatior*): A review on its botanical aspects, phytoconstituents and pharmacological activities. *Pakistan Journal of Biological Sciences, 21,* 151-165.

Kaprasob, R., Rungruang, R., Kaisangsri, N., Kerdchoechuen, O., & Laohakunjit, N. (2016). Volatile compounds of *Etlingera elatior* extracts by SPME gas chromatography mass spectrometry. *Agricultural Science Journal, 47*(2) (Suppl.), 221-224.

Kowalska, J., Marzec, A., Domian, E., Galus, S., Ciurzyńska, A., Brzezinska, R., & Kowalska, H. (2021). Influence of tea brewing parameters on the antioxidant potential of infusions and extracts depending on the degree of processing of the Leaves of *Camellia sinensis*. *Molecules, 26,* 4773.

Lachumy, S.J.T., Sasidharan, S., Sumathy, V., & Zuraini, Z. (2010). Pharmacological activity, phytochemical analysis and toxicity of methanol extract of *Etlingera elatior* (torch ginger) flowers. *Asian Pacific Journal of Tropical Medicine, 3,* 769-774.

Liu, S., Chang, X., Liu, X., & Shen, Z. (2016). Effects of pretreatments on anthocyanin composition, phenolics contentsand antioxidant capacities during fermentation of Hawthorn (*Crataegus Pinnatifida*) drink. *Food Chemistry, 212,* 87–95.

Lu, Q. Peng,Y. Zhu, C., & Pan S. (2018). Effect of thermal treatment on carotenoids, flavonoids and ascorbic acid in juice of orange cv. Cara Cara, *Food Chemistry, 265,* 39-48.

Ministry of Public Health. (2021). *Announcement of ministry of public health notification no.426 "Tea infusion".* March 25, 2021.

Nithitanakool, S., Teeranachaideekul, V., Ponpanich, L., Nopporn, N., Junhunkit, T., Wanasawas, P., & Chulasiri, M. (2014). In vitro and in vivo skin whitening and anti-aging potentials of hydroglycolic extract from inflorescence of Etlingera elatior. *Journal of Asian Association of Schools of Pharmacy, 3,* 314-325.

Rachkeeree, A., Kantadoung, K., Suksathan, R., Puangpradab, R., Page, P.A., & Sommano, S.R. (2018). Nutritional compositions and phytochemical properties of the Edible flowers from selected Zingiberaceae found in Thailand. *Frontiers in Nutrition, 5,* 3.

Ravikumar, C. (2014). Review on herbal teas. *Journal of Pharmaceutical Science and Research, 6*(5), 236-238.

Resurreccion, A.V.A. (1998). *Consumer sensory testing for product development.* Gaitherburg, MD: Aspen.

Roe, J.H., Mills, M.B., Oesterling, M.J., & Damron, C.M. (1948). The determination of Diketo-l-Gulonic acid, dehydro-l-ascorbic acid in the same tissues extract by the 2,4-dinitrophynylhydrazine method. *Journal of Biological Chemistry, 174,* 201-208.

Rossi, M., Giussani, E., Morelli, R., Scalzo, R.L., Nani, R.C., & Torreggiani, D. (2003). Effect of fruit blanching on phenolics and radical scavenging activity of highbush blueberry juice. *Food Research International, 36,* 999-1005.

Srey, C., Sontimuang, C., Thengyai, S., Ovatlarnporn, C., & Puttarak, P. (2014). Anti "-glucosidase, anti "-amylase, anti-oxidation and anti-inflammation activities of *Etlingera elatior* rhizome. *Journal of Chemical and Pharmaceutical Research,* 6, 885-891.

Stevens, R., Buret, M., Duffe, P., Garchery, C., Baldet, P., & Rothan, C. (2007). Candidate genes and quantitative trait loci affecting fruit ascorbic acid content in three tomato population. *The Journal of Plant Physiology, 143,* 1943–1953.

Sukporn, S., Sirimuangmoon, C., Kondo, S., & Sutthiwal, S. (2019). Effect of harvesting season, maturity stage and storage temperature on internal browning and postharvest quality of 'Phulae' pineapple. *Journal of Food Science and Agricultural Technology, 5* (Spcl. Iss.), 212-219.

Sun, H., Ni, H., Yang, Y., Wu, L., Cai, H.N., Xiao, A.F., & Chen, F. (2014). Investigation of sunlight-induced deterioration of aroma of pummelo (*Citrus maxima*) essential oil. *Journal of Agricultural and Food Chemistry, 62*(49), 11818–30.

Susanti, D., Awang, N.A., Qaralleh, H., Mohamed, H.I.S., & Attoumani, N. (2013). Antimicrobial activity and chemical composition of essential oil of Malaysian *Etlingera elatior* (Jack) RM smith flowers. *Journal of Essential Oil Bearing Plants, 16,* 294-299.

Taufik, Y., Widiantara, T., & Garnida, Y. (2016). The Effect of drying temperature on the antioxidant activity of black mulberry leaf tea (*Morus Nigra*). *Rasayan Journal of Chemistry, 9,* 889-95.

Um, M., Kim, J. W., & Lee, J. W. (2020). Optimization of ascorbic acid extraction from Rugosa Rose (Rosa rugosa Thunb.) fruit using response surface methodology and validation of the analytical method. *Journal of the Korean Wood Science and Technology, 48*(3), 364-375.

Wijekoon, M.J.O., Bhat, R., & Karim, A.A. (2011). Effect of extraction solvents on the phenolic compounds and antioxidant activities of bunga kantan (*Etlingera elatior* Jack.) inflorescence. *Journal of Food Composition and Analysis, 24*(4-5), 615-619.

Wijekoon, M.M.J.O., Bhat, R., Karim, A.A., & Fazilah, A. (2013). Chemical composition and antimicrobial activity of essential oil and solvent extracts of torch ginger inflorescence (*Etlingera elatior* Jack.). *International Journal of Food Properties, 16,* 1200-1210.

Zhang, L.L., Wu, G.S., Wang, W.B., Yue, J.Y., Yue, P.X., & Gao, X.L. (2019). Anthocyanin profile, color and antioxidant activity of blueberry (*Vaccinium ashei*) juice as affected by thermal pretreatment. *International Journal of Food Properties, 22*(1), 1036-1046.

Zoghbi, M.G.B., & Andrade, E.H.A. (2005). Volatiles of the *Etlingera elatior* (Jack) R.M.S. and Zingiber spectabile Griff.: Two Zingiberaceae cultivated in the Amazon. *Journal of Essential Oil Research, 17,* 209-211.