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Ginger (Zingiber officinale) Mass Ratio on Physicochemical And Sensory Characteristics of Liang Tea

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Abstract

*The study aims to find out the effect of ginger mass ratio on the physicochemical and sensory characteristics of liang tea. The ingredients of liang tea was consisting of the leaves of D.chinensis, T.spathacea, O.vulgare, P.amaryllifolius, stem bark of secang woods (Caesalpinia sappan), midrib skin of lidah buaya (Aloevera chinensis) and rhizome of ginger with certain mass ratio. The treatment was in the form of mass ratio of liang tea and ginger rhizome powder (20:0; 20:1; 20:2; 20:3; 20:4; 20:5; 20:6; 20:7). Parameters to observed are physical characters include color, pH and chemical characters include qualitative phytochemical testing, vitamin C content, total phenol content, total flavonoid content and antioxidant activity with DPPH inhibitory activity and followed by sensory characteristic. The results showed that the formulation of the mass ratio of liang tea:ginger 20:0 possess the highest value on total phenolic content, flavonoid content and antioxidant activity (43.62 ± 5.64 mg GAE/g, 39.69 ± 1.32 mg QE/g and 56.02 ± 1.74 % respectively). The color value of tea which possess the highest phytochemical content and antioxidant activity are *L value (28.6±0), *a (4.1±0), *b (3.7±0), *c (5.5±0) and *h (42.35±0.14). Sensory characteristic showed that liang tea and ginger with mass ratio 20:0 was the best result, with colour value (3.93±0.91), flavor (3.57±0.94), taste (3.60±0.97), sweetness (3.77±0.97) and fondness overall (3.80±0.85) Based of the results of Index effectivity showed that liang tea and ginger with mass ratio 20:0 showed the best formulation as rich-antioxidant liang tea.*

Keywords: antioxidant; ginger; liang tea; phytochemical

INTRODUCTION

Herbal tea is a popular drink originated from China and consumed in worldwide due to its beneficial effect on health (Rotta et al., 2016). Herbal tea which served by infusion is a beverage obtained from parts of the plant (dry leaves, flowers and fruits) or the shoot of several herbs or aromatic plant (Saucedo *et al.*, 2020). One of herbal tea namely Liang tea, is a traditional drink (Dewi et al., 2021). According of Kosinska and Andrauler (2014), herbal tea was valued because its taste, aroma, health benefits and cultural practice. It is mainly consisting of one herbal ingredient or a mixture of some herbal ingredients to provide a particular purpose, such as relief from a specific condition or rejuvenation (Ravikumar, 2014).

Liang tea that being commerced at Pontianak City, Indonesia, consists of a blend of herbs: *Dicliptera chinensis*, *Pandanus amaryllifolius*, *Aloe vera*, *Origanum vulgare, Caesalpinia sappan*, and *Tradescantia spathacea*. Each of the mentioned herbs was known to have a medicinal effect on the human body (Lin *et al.*, 1993, Jimtaisong and Krisdaphong, 2013, Zhao et al., 2008, Naquvi et al., 2019, Kumar et al., 2019, Avila et al., 2003).

The interest in tea as a health-promoting beverage is growing, leading to the development of beverages (Vilaplana et al., 2015). People usually consume tea for its attractive taste and aroma (Oduro et al., 2013). One of the ways to develope and improve sensory characteristic of tea is by adding ginger in tea formulation. Ginger

(*Zingiber officinale Roscoe*) which belong to the *Zingiberaceae* family has been utilized as flavoring agent and medicinal purpose since long time ago (Han et al., 2013). Many bioactive compounds in ginger had been identified, such as phenolic and terpenes compounds. Ginger possess approximately 1.0 to 2.5 pungent constituents (a non-volatile oily liquid consisting of homologous polyphenols) that give ginger its pungent or spicy quality (Zick et al., 2010). The phenolic compounds are mainly gingerols, shogaols, and paradols which account for the various bioactivities of ginger (Stoner, 2013). According to sensory evaluation on green and black tea study from Supartono *et al.* (2015), brewed tea with ginger addition gained the highest score on flavor and almost highest consumer acceptance. The idea of this study is to formulate of liang tea sold in Pontianak City, with a different ratio of *ginger* rhizome. The addition of *ginger* in liang tea formulation can improve the sensory appeal of the tea, especially the flavor due to the biomolecule of gingerol and shogaol which cause pungency (Mele, 2019) of and also its colour due to anthocyanin (Ijima *et al.*, 2003). There is no previous study about tea with same herbal ingredients as commerce in Pontianak City along with ginger addition. The research about phytochemical content and the bioactivity of liang tea is important to provide and inform the scientific data to consumers to validate the tea as a health-promoting beverage. This research aims to find out the effect of the addition of *Zingiber officinale* in various ratios toward phytochemical content and antioxidant activity of liang tea.

METHODOLOGY

Materials

The leaves of *Pandanus amaryllifolius*, *Origanum vulgare*, *Tradescantia spathacea*, *Dicliptera chinensis*, stem bark of *Caesalpinia sappan*, skin of *Aloevera chinensis* and rhizome of *Zingiber officinale* were brought from local marketplace. The materials were washed, cleaned carefully, and dried using a cabinet dryer at 50^{o}C for 12 hours. The dried materials were finely powdered with the grinder and sieved to 80-mesh size. The powder were stored in the plastic jar at room temperature.

The chemicals and reagents used were analytical grades. Gallic acid, natrium carbonate (Na_2CO_3), *folin-ciocalteu* reagent, ethanol, Potassioum iodide, amilum, iodin, aluminum (III) chloride ($AlCl_3$), $NaNO_2$, quercetin, natrium hydroxide (NaOH), were obtained from Merck (Darmstadt, Germany). *1,1-Diphenyl-2-picrylhydrazyl* (DPPH) were obtained from Sigma (Sigma-Aldrich, Germany). Aquabidest were obtained from a local chemical store.

Sample Preparation

There are eight formulations of *Liang tea* that were used in this present study. The mass ratio of the herbs of *Dicliptera chinensis, Pandanus amaryllifolius, Caesalpinia sappan, Aloevera chinensis, Oreganum vulgare, Tradescantia spathacea* were 10:1:4.5:1:1:2.5 respectively, and the ratio of *Zingiber officinale* mass weight *were* 0, , 2, 3, 4,5, 6,7 w/w. Liang tea composition were shown in Table 1. The herbs powder was mixed according to the treatment and the liang tea was prepared by performed by Dewi *et al.* (2021) with some modification. 1 sachet of liang tea according of the treatment were transfered to beaker glass then heated with 200ml aquabidest at 80-90^{o}C and stirred with magnetic rod for 6 minutes. All of liang teas were added xylitol as sweetener. The liang tea were stored in refrigerator with

4°C for 24 hours and filtrated through Whatman paper no.1. The filtrate of liang tea then stored at freezer until further analysis.

Table 1. Herb composition for each formulation in liang tea sachet

Ingredients	Formulation (g)							
	0	1	2	3	4	5	6	7
Dicliptera chinensis	10	10	10	10	10	10	10	10
Pandanus amaryllifolius	1	1	1	1	1	1	1	1
Caesalpinia sappan	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Aloevera chinensis	1	1	1	1	1	1	1	1
Origanum vulgare	1	1	1	1	1	1	1	1
Tradescantia spathacea	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Zingiber officinale	0	1	2	3	4	5	6	7

Parameter

pH

The pH was measured by using pH meter (AMT20) and standardized by buffer solutions of pH 4, 7 and 10 following the method as described in AOAC (2007).

Vitamin C

Vitamin C determination were carried out by iodine titration following the procedure of Ikewuchi and Ikewuchi (2011).

Determination of Total Phenolic Content (TPC)

Total phenolic content of tea was determined according to the method based on Quan *et al.* (2014) with some modification. Liang tea sample (0.5 ml) followed by Folin-Ciocalteu reagent (2.5ml) was added to testing tube and let it stand for 5 minutes at dark and ambient temperature. After that, 7.5% (w/v) Na_2CO_3 was added to the solution and the mixture were homogenized using vortex mixer (VM 300) and placed in dark place at room temperature. A blank solution was prepared with the same manner by using ddH_2O (0,5ml). Absorbance were measured at 765nm using spectrophotometer (Shimadzu UV mini 1240). The results were expressed in gallic acid equivalents per gram of liang tea through gallic acid calibration curve (0 – 140 µg/mL).

Determination of Total Flavonoid Content (TFC)

Total flavonoid content by aluminium chloride method was performed based on Jaiswal *et al.* (2012) modified by Dewi *et al* (2021). Each tea sample (250 µL) followed by ddH_2O (1.25ml) and lastly 5% sodium nitrite solution (75 µL) were added to testing tube. After 6 minutes, 10% aluminium chloride solution (150 µL) was added along with 1M sodium hydroxide (0.5ml) and ddH_2O (575 µL) was added to bring the total volume to 2.5ml. A blank solution was prepared in the same procedure by using ddH_2O instead of tea sample. Absorbance were measured at 510nm. The results were expressed in quercetin equivalents per gram of liang tea through quercetin calibration curve (0 – 140 µg/mL).

Determination of Antioxidant Activity

The determination of antioxidant activity by DPPH scavenging method was performed according to a method based on Quang and Eun (2011) with some modification. The DPPH solution was prepared by diluting stock DPPH solution (0.24g/L) with methanol until the absorbance reached 1.1 ± 0.01 at 515nm. Liang tea (0.15ml) was mixed with DPPH solution (2.85ml) and the mixture was left for 15 minutes in dark place at room temperature. The solution then measured using spectrophotometer (Shimadzu UV mini-1240) at 515nm wavelength. A blank solution also prepared with the same procedure by using methanol instead of tea sample (0.15ml). Antioxidant by DPPH scavenging activity was calculated using the following formula :

$$\text{DPPH inhibition (\%)} = [(A_b - A)/ A_b] \times 100$$

Where A_b= absorbance of control (blank) and A_e = absorbance of tea sample.

Organoleptic Evaluation

Organoleptic evaluation was performed by hedonic test described by Patang and Syam (2018) with some modification. There were 30 trained panelists and 8 tea samples were served based on preparation method, along with tea 20:0 ginger mass ratio and sucrose as the sweetener served as control. Sensory characteristic of tea included colour, flavor, taste, sweetness and fondness which being given score based on panelist preference ranged from 1 (very dislike) to 5 (very like).

Effectivity Index

Effectivity index was carried out by De Garmo (1984) method which determine the effectivity value followed by determination of the best treatment.

Statistical Analysis

The data was analyzed as mean ± standard deviation values by repeating the procedures in three replications. The standard deviation values were determined by using one-way analysis of variance (ANOVA) followed by multiple comparisons by Tukey test when the observed parameters considered statistically different. Sensory characteristic evaluation were determined by Kruskal Wallis test, when KW > x^2, the mass ratio of ginger on liang tea formulation significantly affect against the sensory characteristic. The statistical data was analysed by using Microsoft Excel and visualised using charts.

RESULTS AND DISCUSSION

Physicochemical characteristics of Rich Antioxidant Liang Tea with Various Ginger Mass Ratio

Physicochemical characteristic for each component of rich-antioxidant liang tea has been analyzed and the data shown in Table 2.

Phytochemical Screening

Qualitative test by phytochemical screening on plant extracts showed significant indication about the presence of certain metabolites (Soni *et al.*, 2017). The presence of phytochemical like alkaloid, flavonoid, phenol, tannin and terpenoid are shown in Table 3. The phytochemical screening showed that the tea with various ginger formulation has positive result on the presence of alkaloids, flavonoids,

phenols, tannins and terpenoids. According to Aji *et al* (2022), the hydro ethanolic extract of *Zingiber officinale* contain positive result on alkaloid, flavonoid and triterpenoid. Osabor *et al* (2015) reported that aqueous extract of *Zingiber officinale* contain positive result on cardiac glycoside, alkaloid, flavonoid, polyphenol and reducing sugars. According to Mohan *et al* (2011), *Caesalpinia sappan* aqueous extract contain positive result on alkaloids, steroids, tannins, flavonoids, terpenoids, protein and carbohydrate that cover the result for the phytochemical screening of *Zingiber officinale* as the main treatment in liang tea formulation.

Table 2. Physicochemical characteristic of fresh ingredientsof rich-antioxidant liang tea

Ingredients	Moisture content (%)	Ash content (%)	Vitamin C
Dicliptera chinensis*	81.26±0.83	0.15±0.03	2.42±0.38
Pandanus amaryllifolius*	66.19±5.79	0.31±0.05	2.2±0.44
Stem bark of Caesalpinia sappan**	9.43±0.94	0.58±0.22	2.68±0.32
Aloe vera	91.37±0.04	0.08±0.00	0.95±0.13
Origanum vulgare Wilder*	81.65±3.11	0.14±0.02	2.13±0.34
Tradescantia spathaceae Sw.*	91.70±1.54	0.09±0.01	0.88±0.44
Zingiber officinale****	89.30±1.34	0.11±0.01	2.05±0.34

Description: *: lea; **: dried stem bark (commercial); ***: midrib; ****: rhizome.

Table 3. Phytoscreening of tea with various formulation

Treatment	Alkaloids	Flavonoids	Phenols	Tannins	Terpenoids
Tea 20:0 Ginger	+	+	+	+	+
Tea 20:1 Ginger	+	+	+	+	+
Tea 20:2 Ginger	+	+	+	+	+
Tea 20:3 Ginger	+	+	+	+	+
Tea 20:4 Ginger	+	+	+	+	+
Tea 20:5 Ginger	+	+	+	+	+
Tea 20:6 Ginger	+	+	+	+	+
Tea 20:7 Ginger	+	+	+	+	+
Tea 20:0 Ginger	+	+	+	+	+

pH

pH value of liang tea with various formulation were shown in figure 1. There is significant different between the mass ratio of ginger on liang tea formulation against pH value. The pH value ranged to 6.07 ± 0.08 to 7.25 ± 0.04 which liang tea with ginger 7 weight ratio has the highest value. pH value increased simultaneously as much as the higher weight ratio of ginger in the formulation of the liang tea.

Vitamin C

Vitamin C content of tea with various formulation of ginger weight ratio has been shown in figure 2. Vitamin C value ranged from 0.88 ± 0.0 to 1.47 ± 0.67 which the highest result obtained from liang tea with ginger 3 weight ratio. There is no significant different between the mass ratio of ginger on tea formulation against vitamin C content. There was no previous study about liang tea with various ginger rhizome powder mass ratio effect on vitamin C content. According to Alikali *et al.*

(2016), vitamin C content increased as the ratio of ginger in tea were decreased. Vitamin C content of ginger rhizome was reported about 3.75 ± 0.58 mg/100g dry weight (Shahid and Hussain, 2012).

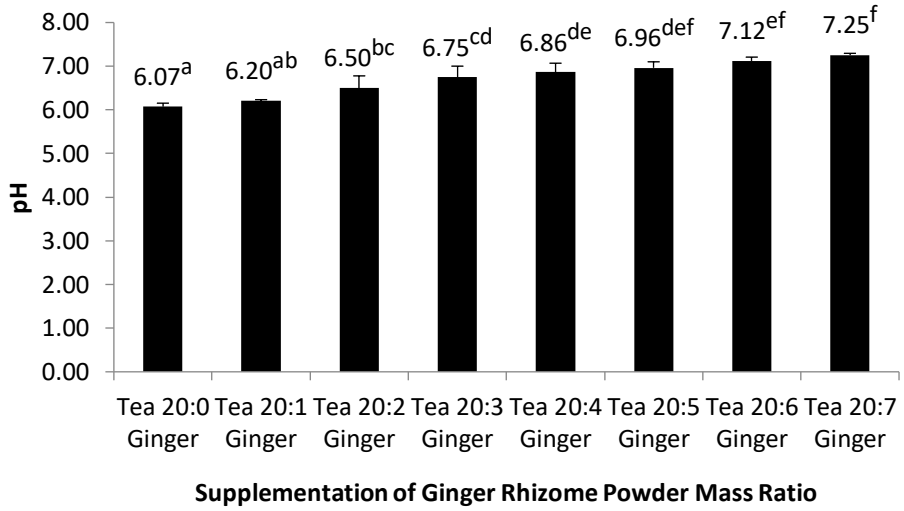

Figure 1. pH of liang tea with various supplementation of ginger rhizome mass ratio

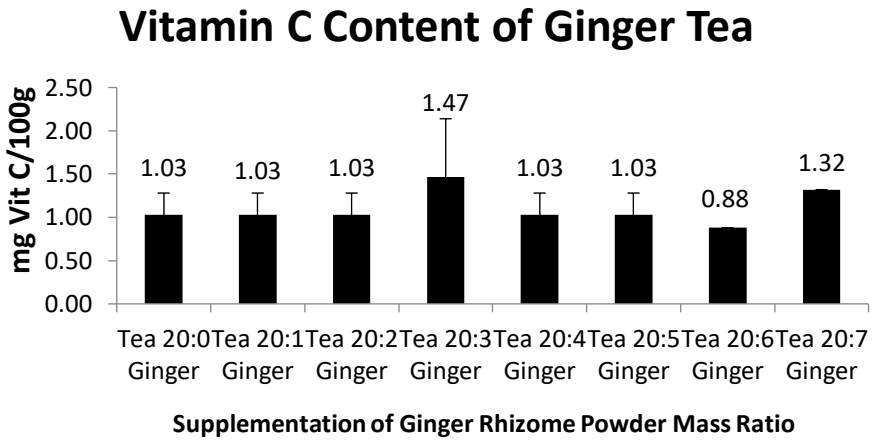

Figure 2. Vitamin C content of tea with various supplementation of ginger mass ratio

Total Phenolic Content

The amount of total phenolic content of liang tea with various formulation has been shown in figure 3. There is significant different between the mass ratio of ginger on liang tea formulation against total phenolic content. Total phenolic content of the liang tea varied from 6.42 ± 0.15 to 40.20 ± 6.96 mg GAE/g dry weight which the highest value obtained from ginger 0. Imran *et al.* (2021) reported that the amount of total phenolic content of ginger powder that extracted with water solvent was about 498 ± 2.98 mg GAE/100g ginger. Total phenolic content value tend to be decreased as the ginger ratio increased until reach its lowest value at ratio 6 and being increased at ratio 7. The result is different compared to Alikali et al. (2016) which the decreased amount of ginger concentration in herbal tea leads to increment of phenolic content. This results are believed due to pH of the tea solution. Tea polyphenol was known to be degraded faster with the increase of either pH, oxygen concentration, or temperature (Zimeri and Tong, 1999). Tea polyphenols were very

unstable in neutral to alkaline solutions and decomposed in a few minutes, whereas they were relatively stable under acidic conditions (Zhu *et al.*, 1997).

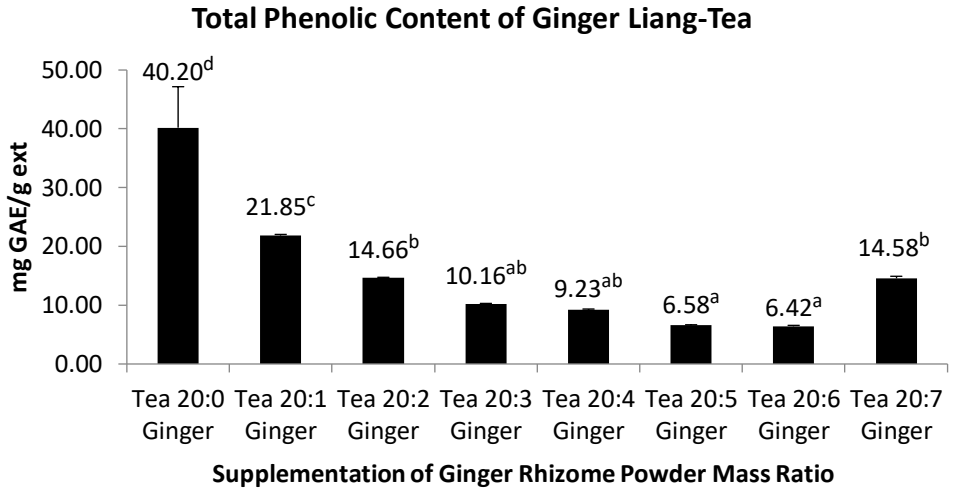

Figure 3. Total phenolic content of liang tea with various supplementation of ginger rhizome mass ratio

Total Flavonoid Content

The amount of total flavonoid content of liang tea with various formulation has been shown in figure 4. There is significant different between the mass ratio of ginger on liang tea formulation against total flavonoid content. Total flavonoid content of the tea varied from 5.13 ± 0.15 to 25.33 ± 0.40 mg GAE/g dry weight which the highest value obtained from ginger 0 formulation. Total flavonoid content of ginger rhizome was reported approximately about 1.48 ± 0.1 to 4.14 ± 0.13 mg QE/g dryweight (Ghasemzadeh *et al.*, 2010). Same with total phenolic content, total flavonoid content value also tend to be decreased as the ginger ratio increased until reach its lowest value at ratio 6 and being increased at ratio 7. Flavonoids, especially Anthocyanins are stable at low pH. It becomes less stable when exposed to heat, causing a loss of color and browning. As a result, high temperature, increased sugar level, pH, and ascorbic acid can affect the rate of destruction (Wahyuningsih *et al.*, 2017).

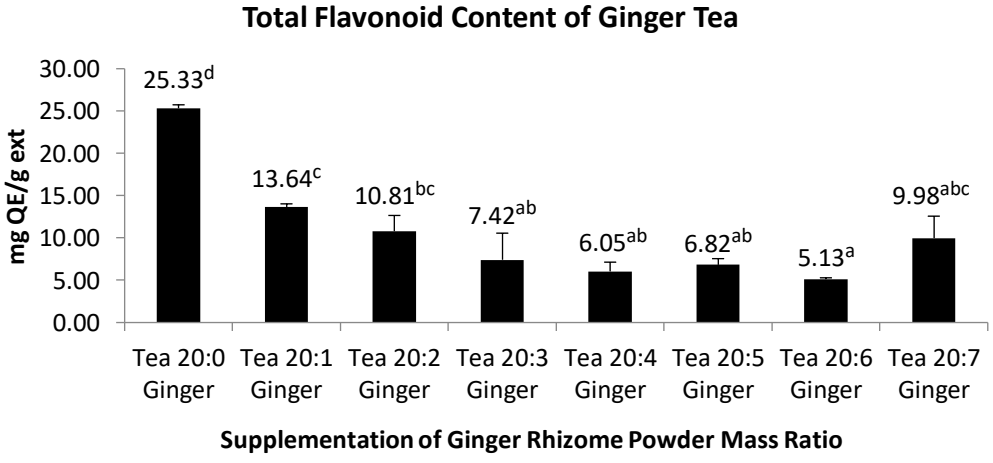

Figure 4. Total flavonoid content of liang tea with various supplementation of ginger rhizome mass ratio

Antioxidant by DPPH Scavenging Activity

Antioxidant activity by DPPH radical scavenging method of Liang tea are shown in figure 5. There is significant different between the mass ratio of ginger on liang tea formulation against antioxidant activity. Antioxidant activity of the tea varied from 6.46 ± 1.44 to 42.18 ± 2.29 % which the highest value was obtained from ginger 0 formulation. This result is similar to Sofiah *et al.* (2021) which the higher concentration of ginger powder in the mixture of liang tea decrease antioxidant activity. Antioxidant activity value decreased and reached its lowest at ratio 6 formulation and increased for the next formulation and the result were same and correlated against both total phenolic and total flavonoid content. There is a strong correlation between total flavonoid content and total phenolic content against antioxidant activity by DPPH radical scavenging activity method (Yakubu *et al.*, 2014; de-Souza *et al.*, 2008). According to Bayliak *et al.* (2016), Antioxidant activity of plant extracts is inhibited in alkaline medium. The presence of oxygen or transitional metal ions and alkaline pH conditions triggers prooxidant activity of phytochemical.

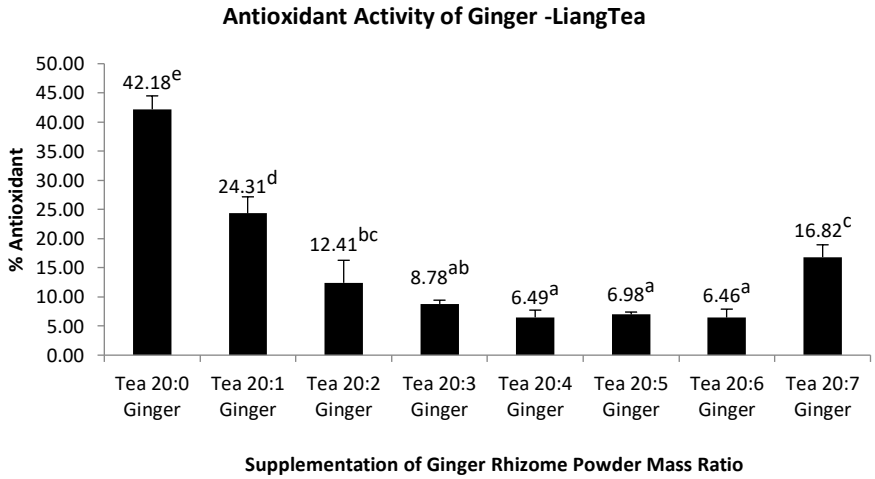

Figure 5. Antioxidant activity of liang tea with various supplementation of ginger rhizome mass ratio

Colorimetric of Rich-Antioxidant Liang Tea

Colour was determined based on International Commission on Illumination (CIE) L*a*b* system, where L* for lightness, a* for redness or greenness, and b* for yellowness or blueness (Wang *et al.*, 2019). There is significant different between the mass ratio of ginger on liang tea formulation against all of colour index value. The colorimetric of tea with various ginger formulation are shown in Table 4. The result showed that the lightness of tea were increased as the much as the ginger ratio in tea formulation, heading toward to green colour as higher the ratio of ginger in tea formulation but back to redness again at ratio 7 ginger treatment, and slightly increase the blueness of tea as the ratio of ginger in liang tea formulation increased. Chroma (C*) considered as the quantitative indicator of colourfulness, is used to determine the degree of difference in a hue in comparison to a grey colour with the same lightness. The higher the chroma values, the higher colour intensity of samples is perceived by humans, which means the higher amount of ginger added in liang tea, the lower intensity of the colour of tea while it were increased at ratio 7 ginger formulation. Hue angle (h*), considered the qualitative indicator of colour, is an

attribute according to which u have been traditionally defined as reddish, greenish, etc., and is used to define the difference of a certain colour with the reference to grey colour of the same lightness. The higher amount of ginger in liang tea formulation, the higher the h value. A higher hue angle represents a lesser yellow character in the assays and a greater redness intensity (Granato and Masson, 2010).

Table 4. Colorimetric of liang tea with various supplementation of ginger rhizome mass ratio

Treatments	L	A	b	C	h
Tea 20:0 Ginger	30.3 ± 0.14^{a}	2.5 ± 0^{h}	3.35 ± 0.07^{e}	4.1 ± 0^{e}	53.25 ± 0.07^{b}
Tea 20:1 Ginger	31.2 ± 0.07^{b}	1.6 ± 0^{b}	1.3 ± 0^{ab}	2.1 ± 0^{c}	37.55 ± 0.21^{a}
Tea 20:2 Ginger	33.25 ± 0.07^{d}	-1.1 ± 0^{a}	2.2 ± 0^{d}	3.35 ± 0.21^{d}	92.65 ± 0.35^{d}
Tea 20:3 Ginger	32.9 ± 0^{c}	-0.45 ± 0.07^{e}	2.1 ± 0.14^{bc}	2.05 ± 0.07^{bc}	102.25 ± 0.21^{e}
Tea 20:4 Ginger	33.05 ± 0.07^{cd}	0.1 ± 0^{c}	1.75 ± 0.07^{cd}	1.65 ± 0.07^{a}	85.6 ± 0.71^{c}
Tea 20:5 Ginger	33.9 ± 0^{ef}	-0.3 ± 0^{f}	1.6 ± 0^{a}	1.7 ± 0^{ab}	103.55 ± 3.04^{e}
Tea 20:6 Ginger	33.95 ± 0.07^{f}	-1 ± 0^{g}	1.65 ± 0.07^{e}	1.95 ± 0.07^{abc}	120.9 ± 0.28^{f}
Tea 20:7 Ginger	31.4 ± 0.14^{b}	2.6 ± 0^{d}	2.95 ± 0.21^{ab}	4 ± 0.14^{e}	48.55 ± 2.47^{b}

Sensory Characteristic of Liang Tea

Sensory characteristic of rich-antioxidant liang tea with various mass weight ratio of ginger were shown in table 5. Colour value ranged from 2.53 ± 0.82 to 4.5 ± 0.68 which the highest value on tea with ginger mass ratio 2. Flavor ranged from 2.77 ± 0.68 to 3.57 ± 0.94 which the highest value on tea without ginger. Taste value ranged from 3.3 ± 0.99 to 3.77 ± 0.9 which the highest value on tea with ginger mass ratio 3. Sweetness value varied from 3.13 ± 0.78 to 3.77 ± 0.97 which the highest value on tea without ginger. Fondness value ranged from 3.17 ± 0.87 to 3.85 ± 0.85 which the highest value on tea without ginger.

According to the result, the mass ratio of ginger on liang tea formulation affect the sensory characteristic of the tea. The addition of ginger in liang tea formulation increase the colour sensory characteristic as the panelist given the highest score on tea with ginger mass ratio 2 and being decreased as the larger mass ratio of ginger. It was believed that anthocyanin from the ginger affect the colour of tea and turned to pinkish colour and being darker as the larger mass ratio of the ginger in liang tea formulation which affect the panelist preference. On flavor characteristic, the addition of ginger affect the score by the panelist and being decreased as the larger mass ratio of the ginger were added in formulation. Ginger is well known for its strong pungent odor and may not fit the tea sensory characteristic as the panelist dislike and given the lower score on liang tea with ginger.

On taste characteristic, the addition of ginger in liang tea formulation being preferred by panelist as it has the highest score on ginger with mass ratio of 3. It is due to some chemical compounds from ginger like shogaols and gingerols that cause pungency and enriching the taste of the tea itself (Imran *et al.*, 2021). According to Sofiah *et al.* (2021) reported that taste sensory characteristic is higher as well as the more ginger powder was added in the tea mixture. The addition of ginger on liang tea formulation affect the sweetness score as the panelist given the lower score. Bitterness and astringency especially in beverages influenced by flavonoid phenols, primarily flavanol polymers, and also level of ethanol, pH, sweetness and viscocity

(Lesschaeve and Noble, 2005). The larger mass ratio of ginger increase the pH value of tea from slight acidic to neutral (as shown on figure 1.) and phytochemical compounds from ginger might decrease the sweetness of the tea. The addition of ginger in liang tea formulation decrease the fondness overall as the panelist given the highest score on tea without ginger.

Table 5. Sensory characteristic of rich-antioxidant liang tea with various supplementation of ginger

Treatments	Colour	Flavor	Taste	Sweetness	Fondness
Tea 20:0 Ginger	3.93 ± 0.91	3.57 ± 0.94	3.6 ± 0.97	3.77 ± 0.97	3.8 ± 0.85
Tea 20:1 Ginger	3.97 ± 0.93	3.2 ± 0.81	3.33 ± 1.09	3.3 ± 1.15	3.33 ± 0.88
Tea 20:2 Ginger	4.5 ± 0.68	3.3 ± 0.75	3.5 ± 1.04	3.4 ± 1.04	3.63 ± 1.03
Tea 20:3 Ginger	3.63 ± 0.93	3.27 ± 0.83	3.77 ± 0.9	3.5 ± 0.9	3.57 ± 0.77
Tea 20:4 Ginger	3.3 ± 0.99	3.23 ± 0.86	3.53 ± 0.86	3.53 ± 0.94	3.5 ± 0.86
Tea 20:5 Ginger	3.17 ± 0.99	3.2 ± 0.76	3.4 ± 0.67	3.47 ± 1.14	3.37 ± 0.85
Tea 20:6 Ginger	2.83 ± 2.53	2.77 ± 0.68	3.33 ± 0.8	3.23 ± 0.97	3.2 ± 0.66
Tea 20:7 Ginger	2.53 ± 0.82	2.83 ± 0.91	3.3 ± 0.99	3.13 ± 0.82	3.17 ± 0.87
Tea 20:0 Ginger (sucrose)	4.17 ± 0.91	3.33 ± 0.76	3.37 ± 0.89	3.13 ± 0.78	3.53 ± 0.82
$x^2 = 16$	KW = 76.64	KW = 17.64	KW = 5.95	KW = 10.37	KW = 12.05

Value of Effectivity Index

Value of effectivity index of physicochemical characteristic of rich-antioxidant liang tea with various substitution of ginger rhizome and sensory characteristic was showed at Table 6 and 7 respectively.

Table 6. Effectivity index of physicochemical characteristic of rich-antioxidant liang tea with various supplementation of ginger

Mass Ratio of Ginger (w/w)	Effectivity Value
Tea 20:0 Ginger	**0.68**
Tea 20:1 Ginger	0.30
Tea 20:2 Ginger	0.38
Tea 20:3 Ginger	0.38
Tea 20:4 Ginger	0.27
Tea 20:5 Ginger	0.30
Tea 20:6 Ginger	0.29
Tea 20:7 Ginger	0.54

Table 7. effectivity index of sensory characteristic of rich-antioxidant liang tea with various supplementation of ginger

Mass Ratio of Ginger (w/w)	Effectivity Value
Tea 20:0 Ginger	**0.86**
Tea 20:1 Ginger	0.40
Tea 20:2 Ginger	0.67
Tea 20:3 Ginger	0.68
Tea 20:4 Ginger	0.52
Tea 20:5 Ginger	0.38
Tea 20:6 Ginger	0.09
Tea 20:7 Ginger	0.02
Tea 20:0 Ginger (sucrose)	0.48

Based on Table 6 and 7, tea with 0 ginger mass ratio in formulation showed that the best formulation to produce rich-antioxidant liang tea.

CONCLUSIONS

Supplementation of ginger on liang tea formulation didn't affect physicochemical characteristic of tea in a positive way. The formulation of the mass ratio of liang tea:ginger 20:0 showed the best result as it had the highest total phenolic, flavonoid and antioxidant activity (43.62 ± 5.64 mg GAE/g, 39.69 ± 1.32 mg QE/g and 56.02 ± 1.74 % respectively) as well as sensory characteristic with colour value (3.93±0.91), flavor (3.57±0.94), taste (3.60±0.97), sweetness (3.77±0.97) and fondness overall (3.80±0.85).

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