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FULL PAPER

Ginger-flavoured ready-to-drink cocoa beverage formulated with high and low-fat content powder: consumer preference, properties and stability

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Abstract

Cocoa beverage is commonly made from cacao powder combined with other ingredient forming a suspension system. The purpose of this study was to determine the effect of the fat content of cocoa powder (high and low) and the concentration of ginger powder (0-8%) on the properties and the stability of ready-to-drink cocoa beverage applying Completely Randomized Factorial Designs (CRFD). Moreover, the consumer perspective about the quality attributes of cocoa drink was also surveyed to give insights on the important parameters in the cocoa drink. The results showed that viscosity and sedimentation were the two most important parameters determining the acceptability of cocoa beverage. The stability of the ginger-flavoured cocoa beverage was significantly influenced by the fat content of the raw material. The most preferred cocoa beverage was the sample formulated with low-fat cocoa powder and 8% ginger powder. The sample had a lightness level of 29.21, the antioxidant activity of 70.5%, total phenolic content of 9.53 mg GAE/mL cocoa beverage, total flavonoid content of 4.68 mg QE/mL cocoa beverage, pH of 7.68, and viscosity of 18.53 cP.

1. Introduction

Cocoa (*Theobroma cacao* L.) is acknowledged to play a significant role in the socio-economic sector of many countries in the world, including in Indonesia, because global demand for this commodity is high particularly for producing various food products (Kindangen *et al*., 2017). The cocoa beverage is one of the favourite cocoa-derived products in the global market since it was introduced in Europe in the mid of 18th century (Cidell and Alberts, 2006). People's penchant for cocoa derivative products lies in their sensory properties, such as their distinctive colour and flavour (Aprotosoaie *et al*., 2016). Moreover, nowadays, cocoa has been proven to contain polyphenol compounds that have the potential to act as antioxidants (Counet *et al*., 2004; Muhammad *et al*., 2017). The chocolate beverage is generally produced by mixing cocoa powder with other ingredients such as sugar, milk and stabiliser in a hot water (Muhammad, Kongor and Dwettinck, 2020). Based on the fat contents, cocoa powder can be categorized into high-fat (15-22%), medium-fat (8-14%), and low-fat (2-7%) cocoa powder (Vasela *et al*., 2007).

Currently, cocoa 'ready-to-drink' has been developing to become an alternative beverage because of its convenience and practicality for consumers (Rossi *et al*., 2014; Muhammad, Gonzalez, Sedaghat Doost *et al*., 2019). However, it was renowned that during cocoa drink manufacturing, the polyphenol content of cocoa significantly decreases. Hence, incorporating polyphenol -rich ingredients into the final product in order to increase the polyphenol content in the final cocoa-derived products is recommended (Sudibyo, 2012; Muhammad *et al*., 2018). Herbs and spices have been reported to effectively improve antioxidant properties of cocoa-derived products, including in cocoa beverage, as they contain bioactive compounds (Muhammad and Dewettinck, 2017; Praseptiangga *et al.,* 2019; Yoriska *et al.,* 2019; Muhammad, Lemarcq, Alderweireldt *et al.,* 2019; Muhammad, Sedaghat Doost, Gupta *et al*., 2020; Muhammad, Tuenter, Patria *et al.,* 2020). Moreover, herbs and spices can also be useful to enrich the flavour of cocoa-derived products (Ilmi *et al*., 2017; Handiati *et al.,* 2019).

Ginger refers to a spice known to contain phytochemicals (Bartley and Jacobs, 2000), including essential oils (0.5-5.6%), zingiberone, zingiberene, zingiberol, gingerine, vitamins, flavonoids and polyphenols (Raghavan, 2000). There are three well-known types of ginger, which are distinguished by their

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morphology (shape, size, and rhizome colour), namely java ginger, red ginger and white ginger. The latter has been proven to have a soft flavour with a soft aroma and not too spicy and pungent aftertaste compared to java and red ginger (Adnyana and Suciyati, 2012).

The common problem encountered in the cocoa beverage is low suspension stability. As such, the dispersion of cocoa particles and other ingredients are prone to sedimentation greatly affecting the final product quality. Good stability of cocoa beverage represented by no floating particles on the surface nor sediment at the bottom of the container after minimum stirring (Aliakbarian *et al.,* 2017; Muhammad, Gonzalez, Sedaghat Doost *et al.,* 2019). To improve the suspension stability of cocoa beverage, the application of a stabilizer, such as hydrocolloids, is required. Hydrocolloids are well-known to have various functionality in foods, including as a stabilizing agent where the effect highly depends on the type of the hydrocolloids (Manuhara *et al*., 2016; Praseptiangga *et al.,* 2016; Praseptiangga *et al*., 2017; Muhammad, Sedaghat Doost, Gupta *et al*., 2020). Previously, 0.3% xanthan gum type hydrocolloid was successfully applied in cocoa beverage to improve the consistency and its consumer acceptance. The improvement was better than two other stabilizers, namely iota carrageenan and kappa carrageenan (Aribah *et al*., 2020). The addition of xanthan gum can provide consistency since it contains negatively charged ions which can lead to the formation of good stability in beverages (Rowe *et al*., 2006).

Thus, the fat content of cocoa powder and the additional ingredients in the cocoa beverage is hypothesized to influence the consumer preference, properties and stability of the beverage. This research was therefore aimed to investigate the effect of the fat content of cocoa powder (high and low) and the concentration of ginger powder on the consumer preference, properties and stability of ready-to-drink cocoa beverage.

2. Materials and methods

2.1 Materials

High- and low-fat cocoa powder (PT. Frey Abadi Indotama, Indonesia) was used as the main materials in this study. Ginger powder (PT. Jinyoung, Indonesia), xanthan gum (UD. Cipta Kimia Surakarta, Indonesia) and other ingredients such as refined sugar, corn starch, non-dairy creamer and salt attained from a local shop in Surakarta (Central Java, Indonesia) were also used.

2.2 Preparation of cocoa beverage samples

Prior to the beverage making, all materials used in this research were sieved through an 80-mesh sieve following our previous study (Aribah *et al*., 2020). Refined sugar (15 g), cocoa powder (7.5 g) and non-dairy creamer (6 g) were mixed with 1.47 g of corn starch, 0.03 g of salt, and 0.09 g of xanthan gum and stirred constantly until produces a homogeneous mixture. Ginger powder with various concentrations (0%, 2%, 4%, 6%, and 8%) were added to the formula. Mineral water (200 mL, 80°C) was then added to mixed-powder and stirred for 3 mins (Dogan *et al*., 2011). Cocoa beverage formulations are summarized in Table 1.

2.3 Colour, pH, viscosity and sedimentation index determination

The physical properties of cocoa beverage were evaluated in terms of colour, viscosity and sedimentation. The colour properties of the cocoa beverages in terms of the CIELAB system were determined using a Chromameter CR-400, Konica Minolta Optic, Inc. Meanwhile, the pH value of cocoa beverage was measured using a Ohaus Starter 3100 pH meter. The viscosity of the cocoa beverages was analysed using a Brookfield Viscometer Model DV-II+Pro (Brookfield Engineering Lab, Inc. Middleboro, MA, USA) using spindle no.61 at a speed of 60 rpm. A visual assessment was carried out for 7 days to observe the sedimentation index of the product, and thus the

Table 1. Cocoa beverage formulations

Formulations	Materials (g)						
	Cocoa powder	Refined sugar	Creamer	Corn starch	Salt	Xanthan gum	Ginger powder
Low-fat cocoa powder							
F1	7.5	15	6	1.47	0.03	0.09	0
F2	7.5	15	6	1.47	0.03	0.09	0.6
F3	7.5	15	6	1.47	0.03	0.09	1.2
F4	7.5	15	6	1.47	0.03	0.09	1.8
F5	7.5	15	6	1.47	0.03	0.09	2.4
High-fat cocoa powder							
F6	7.5	15	6	1.47	0.03	0.09	0
F7	7.5	15	6	1.47	0.03	0.09	0.6
F8	7.5	15	6	1.47	0.03	0.09	1.2
F9	7.5	15	6	1.47	0.03	0.09	1.8
F10	7.5	15	6	1.47	0.03	0.09	2.4

result was expressed as Sedimentation Index calculated using Equation (1) as described by Rivas *et al.* (2018), where V_s is the volume of sedimented area (indicated by a clear area) and V is the total volume.

$$SI = \left({}^{Vs}/_{V}\right) \times 100 \qquad (1)$$

2.4 DPPH-radical scavenging activity determination

The DPPH (2,2-diphenyl-1-picrylhydrazyl) method as described by Muhammad, Gonzalez, Sedaghat Doost *et al.* (2019) was carried out to estimate the antioxidant activity of the cocoa beverage, cocoa powder and ginger powder. Concisely, sample (0.1 mL) was added to DPPH solution (4 mL, 0.1 mM) following by incubation for 30 mins in the dark. The absorbance was measured using a UV-vis spectrophotometer at 517 nm. The antioxidant activity of the samples was calculated using the formula as shown in Equation (2).

$$Inhibition = \left(1 - \frac{Abs\ sample}{Abs\ control}\right) \times 100\% \qquad (2)$$

2.5 Total phenol analysis

The total phenolic content of the sample was estimated using the Folin-Ciocalteu method following the protocol of Muhammad, Gonzalez, Sedaghat Doost *et al.* (2019). Briefly, 0.2 mL of sample was added to 0.2 mL of Folin-Ciocalteu reagent previously diluted in 1 mL of distilled water. A 6-min incubation at room temperature was then conducted before the mixture was added with Na_2CO_3 solution (2.5 mL, 7%) and distilled water (2.1 mL). Then, the solution was incubated for 90 min at room temperature. An absorbance measurement was performed at 760 nm using a UV-vis spectrophotometer. A standard plot of gallic acid with various concentrations was used to estimate the total phenolic content.

2.6 Total flavonoid assay

The total flavonoid content of cocoa beverage was estimated following the procedure explained by Udayaprakash *et al.* (2015). Sample (0.2 mL) was well-mixed with $AlCl_3$ (5 mL, 0.1 M). A 40-min incubation at an ambient temperature was carried out before the absorbance was detected at 415 nm in a UV-vis spectrophotometer. A standard plot of quercetin with various concentration was employed to estimate the total flavonoid content of the cocoa beverage.

2.7 Internet survey and the compensatory model weighting test

Internet survey involving a total of 100 participating respondents was conducted in this study as the basis of the compensatory model weighting test. The questionnaire as a data collection instrument was displayed in a Google form. The indicators displayed in the form were respondents' biodata, questions of preference on whether the respondents like to drink cocoa beverage, and what parameters affect the quality of cocoa beverage (color, viscosity, sedimentation, nutritional and antioxidant content, and pH). The results obtained from the internet survey were employed in determining consumer preference by utilizing the compensatory model weighting test.

A compensatory model weighting test was utilized in analyzing multi-attribute decision problems: non-dimensional scaling and the additive weighting technique. In addition, this method is also considered meaningful for choosing the best product among alternatives. In this method, the values for all selected attributes must be converted to a common measurement scale by involving an index (Sullivan *et al.,* 2015) which was in this study was determined based on the result of the internet survey.

2.8 Statistical analysis

Completely Randomized Factorial Designs with two factors, with the variation of 0%, 2%, 4%, 6%, and 8% concentration of ginger powder and the variation of the fat content of cocoa powder (high and low) were used in this study. IBM SPSS Statistics 23 software was used to do an analysis of variance (two-way ANOVA), Duncan's Multiple Range Test (DMRT), and Independent-sample T-test. The differences were considered significant at a 0.95 confidence level.

3. Results and discussion

3.1 Colour

Colour is an important parameter and the main quality attributes evaluated by consumers because it influences the consumer's choice and preference even before the product is consumed (Markovic *et al*., 2013). Colour as well as the appearance can be correlated with sensory and nutritional properties as well as defective attributes of the product both visually and non-visually (Pathare *et al*., 2013). The effect of ginger powder concentration and the fat content of cocoa powder on the colour of cocoa beverage is presented in Table 2. As shown in Table 2, there were significant differences between the control and the other eight formulas in the L* value. In general, it was observed that the addition of the ginger powder decreased the L* value. The highest brightness level (L*) was detected in the control sample meaning that the brightness level of the cocoa beverage was affected by ginger powder. Brewed ginger was reported as yellowish-brown (Sulistiani *et al*., 2019). In other words, the higher the concentration of ginger added, the more intense the colour of the brew. Hence, when it is put into a chocolate drink, the lightness of the drink was reduced.

Table 2. Lightness (L*) of the cocoa beverage samples

Concentration of ginger powder (%)	Lightness of cocoa beverage formulated with		Average
	Low-fat cocoa powder	High-fat cocoa powder	
0 (control)	29.77±0.09	28.87±0.08	29.32±0.48^{A}
2	29.60±0.09	28.80±0.05	29.20±0.43^{B}
4	29.50±0.07	28.71±0.10	29.10±0.41^{C}
6	29.32±0.04	28.40±0.11	28.85±0.50^{D}
8	29.21±0.07	28.27±0.11	28.71±0.53^{E}
Average	29.48±0.22^{a}	28.59±0.27^{b}	

Values are expressed as mean±SD. Values with different lowercase superscript within the same column are significantly different (p<0.05). Values with different uppercase superscript within the same row are significantly different (p<0.05).

The fat content of cocoa powder was also shown to have an impact on the L* value of the cocoa drink. The higher the cocoa powder fat, the lower the L* value. High-fat cocoa powder is known to have a lower L* value than low-fat cocoa powder. Generally, the final product quality is influenced by the quality of the raw material. Cocoa powder that has a brighter colour level produce a product with a brighter colour as well. In the context of fat content, the unsaturated fatty acid content in cocoa butter plays a role in the Maillard reaction. This is because during the heating process the unsaturated fatty acids are degraded to produce aldehydes that play a role in the reaction (Nuwiah, 2010). Arnoldi *et al*. (1988) also suggested that during the heating process, fat will be oxidized to form aldehydes and ketones. Fat degradation affects the colour due to the reaction between amino acids and fructose in producing a brown compound (melanoidin) as the product of the Maillard reaction. This is why the colour of high-fat cocoa powder tends to be darker than low-fat cocoa powder (Figure 1).

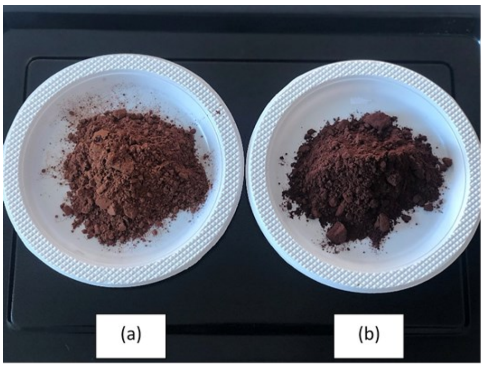

Figure 1. The colour of low-fat (a) and high-fat (b) cocoa powder

3.2 Viscosity

Viscosity is a vital parameter in cocoa beverage since it determines the 'body' of the product. The viscosity of cocoa beverage is based on the interaction between the dispersion phase and the dispersed solid ingredients (El-Khair, 2009). Table 3 shows that the addition of ginger powder increased the viscosity of the cocoa beverages regardless of the type of cocoa powder. It may be because the starch from ginger can form a colloidal solution when heated. Ginger starch contains high amylose content (26.5%) and is categorized as a hydrocolloid (Hanum, 2010). In addition, the greater the concentration of ginger powder, the more solids or particles existed in the cocoa beverage system. In this situation, the interaction among particles in the suspension system was more intensive resulting in a greater viscosity (Lumbantoruan and Yulianti, 2016).

Table 3. Viscosity of the cocoa beverage samples

Concentration of ginger powder (%)	Viscosity of cocoa beverage formulated with (cP)		Average
	Low-fat cocoa powder	High-fat cocoa powder	
0 (control)	16.27±0.27	16.00±0.18	16.13±0.26^{A}
2	17.15±0.22	16.75±0.19	16.95±0.28^{B}
4	17.77±0.12	17.32±0.13	17.54±0.26^{C}
6	18.23±0.23	17.50±0.14	17.87±0.42^{D}
8	18.53±0.16	17.92±0.16	18.23±0.36^{E}
Average	17.59±0.85^{a}	17.10±0.69^{b}	

Values are expressed as mean±SD. Values with different lowercase superscript within the same column are significantly different (p<0.05). Values with different uppercase superscript within the same row are significantly different (p<0.05).

The fat of cocoa powder was also proven to have a substantial effect on viscosity. It was shown that a higher fat of the cocoa powder results in a lower viscosity. Fat is a hydrophobic substance due to its fatty acid contents. Hence, in the aqueous medium, the powder with high-fat content cocoa powder may flow faster than that with low -fat content cocoa powder when determined in a certain shear rate. As a result, the recorded viscosity of cocoa drink made from the high-fat cocoa powder was higher than a cocoa drink made from low-fat cocoa powder (Jeffrey and Acrivos, 1976; Servais *et al*., 2003). Thus, the addition of ginger powder to cocoa beverages shows a positive correlation, since the higher the ginger powder concentration, the more viscosity increases. Meanwhile, the fat content of cocoa powder to cocoa beverages shows a negative correlation, since the higher fat content in cocoa beverage, the viscosity decreases.

3.3 Sedimentation

The appearance of a beverage product is a pivotal factor for consumer acceptance (Muhammad, Gonzalez, Sedaghat Doost *et al*., 2019). In beverages, sedimentation is recognized as a common form of the physical defect (Selamat *et al*., 1998). The result of the sedimentation index determination shows that sedimentation increased along with the proportion of

Table 4. Sedimentation Index (SI) of the cocoa beverage samples

Cocoa Beverage Samples formulated with	Concentration of ginger powder (%)	Days							
		0	1	2	3	4	5	6	7
Low-fat cocoa powder	0 (control)	1.27	43.17	51.75	53.65	58.41	60.00	60.95	61.90
	2	0.95	36.83	42.86	51.43	55.24	60.63	61.90	62.22
	4	2.54	47.62	48.57	58.73	62.22	63.49	63.81	64.44
	6	3.17	51.11	52.70	61.90	64.13	66.03	66.67	66.67
	8	2.86	46.35	48.57	58.41	60.63	61.59	63.17	65.40
High-fat cocoa powder	0 (control)	0.32	48.25	56.83	63.17	66.03	66.67	67.94	68.89
	2	1.59	51.43	57.46	59.05	68.89	70.16	70.48	70.79
	4	3.81	50.79	58.10	59.37	67.62	68.57	70.16	71.43
	6	3.81	48.57	60.00	64.13	66.35	67.30	68.89	71.75
	8	4.13	56.51	58.73	63.49	69.21	69.84	71.11	72.06

ginger powder added to the cocoa beverage (Table 4). The higher the concentration of ginger powder resulted in a higher number of particles resulting in the greater possibility of sedimentation. According to Fitriani *et al.* (2015), drinks that have a large number of solid particles will encourage friction between particles which causes the particles in the suspension to be relatively difficult to move. This frictional force causes the formation of sediment. Therefore, a greater concentration of particles results in a greater probability of particles to deposit in a short time. Several factors influenced the sedimentation rate including the number of particles, viscosity, and particle size (Fitriani *et al*., 2015; Muhammad, Gonzalez, Sedaghat Doost *et al*., 2019). According to previous studies, the cocoa butter content also contributes to the settling rate because cocoa butter is hydrophobic so there is no suspension formed (Juliani *et al*., 2014; Selamat *et al.*, 1998). Thus, it was shown that the addition of ginger powder and fat content of cocoa powder to cocoa beverages has a positive correlation with sedimentation occurrence.

3.4 Antioxidant activity

Antioxidants are chemical components that have the ability to bind oxygen and become donors to free radicals. A significant increase in DPPH-radical scavenging activity by the supplementation of ginger powder to cocoa beverages was demonstrated in this study (Table 5). As such, the cocoa beverage formulated with low-fat cocoa powder and 8% of ginger powder had the highest value of the antioxidant activity which was 70.5%. The control sample (without ginger powder) had the lowest antioxidant activity which was at the level of 58.33%. Meanwhile, the cocoa beverage formulated with high-fat cocoa powder and 8% of ginger powder had the highest antioxidant activity which was 65.50%. The control sample had the lowest value that was 54.50%. Gingerol, shogaol, and zingerone in ginger have been proven to have antioxidant properties that can scavenge free and peroxide radicals, and therefore they are impactful to inhibit oxidation (Kikuzaki and Nakatani, 1993; Nugraha *et al.,* 2015). It was revealed that the cocoa beverages formulated with low-fat cocoa powder had higher antioxidant activity than those with high-fat cocoa powder. According to Muhammad, Gonzalez, Sedaghat Doost *et al.* (2019), the antioxidant cocoa beverage is strongly influenced by the initial content or the antioxidant ability of cocoa powder.

Table 5. Antioxidant activity of the cocoa beverage samples

Concentration of ginger powder (%)	Antioxidant activity of cocoa beverage formulated with (%)		Average
	Low-fat cocoa powder	High-fat cocoa powder	
0 (control)	58.33±2.07	54.50±2.17	56.42±2.84[A]
2	61.17±0.75	61.33±1.97	61.25±1.42[B]
4	63.17±1.47	61.67±1.63	62.42±1.68[BC]
6	65.00±2.00	63.17±1.60	64.08±1.98[C]
8	70.50±2.66	65.50±3.51	68.00±3.95[D]
Average	63.63±4.51[a]	61.23±4.30[b]	

Values are expressed as mean±SD. Values with different lowercase superscript within the same column are significantly different ($p<0.05$). Values with different uppercase superscript within the same row are significantly different ($p<0.05$).

3.5 Total phenolic content

Table 6 shows a significant increase in total phenolic content by the addition of ginger powder to cocoa beverages. The cocoa beverage formulated with low-fat cocoa powder and 8% ginger powder had the highest value of the total phenolic content which was at a level of 9.53 mg GAE/mL of cocoa beverage. The control sample had the lowest phenolic content which was at a level of 7.48 mg GAE/mL of cocoa beverage. Meanwhile, the cocoa beverage formulated with high-fat cocoa powder and 8% of ginger powder had the highest value of the total phenolic content which was at a level of 8.56 mg GAE/mL of cocoa beverage. The control sample had the lowest value which was at a level of 6.94 mg GAE/mL of cocoa beverage. This result is also consistent with the aforementioned data regarding the antioxidant activity of the cocoa beverage. In previous studies, many bioactive compounds in ginger have been identified, such as phenolic, mainly gingerols, shogaols, and paradols, and also terpene compounds. Gingerol was

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reported as the most abundant bioactive compound in ginger with various pharmacological effects including antioxidant, anti-inflammatory, antimicrobial and anticancer properties (Mao *et al.,* 2019). The presence of phenolic compounds in ginger subsequently affect the total polyphenol content of the chocolate drink. Hinneburg *et al.* (2006) stated that ginger extract contained phenols at a level of 23.5 mg gallic acid/g of the sample. Thus, this study showed that in the cocoa beverage the phenolic content is directly proportional with the antioxidant activity.

Table 6. Total phenolic content of the cocoa beverage samples

Concentration of ginger powder (%)	Total phenolic content of cocoa beverage formulated with (mg GAE/mL of cocoa beverage)		Average
	Low-fat cocoa powder	High-fat cocoa powder	
0 (control)	7.48±0.35	6.94±0.19	7.21±0.39^{A}
2	7.96±0.23	7.45±0.36	7.71±0.39^{B}
4	8.61±0.31	8.09±0.10	8.35±0.35^{C}
6	9.23±0.26	8.29±0.15	8.76±0.53^{D}
8	9.53±0.15	8.56±0.16	9.04±0.53^{E}
Average	8.56±0.82^{a}	7.87±0.63^{b}	

Values are expressed as mean±SD. Values with different lowercase superscript within the same column are significantly different ($p<0.05$). Values with different uppercase superscript within the same row are significantly different ($p<0.05$).

3.6 Total flavonoid content

The total flavonoid content of cocoa beverage significantly increased by the addition of ginger powder to cocoa beverages (Table 7). The cocoa beverage formulated with low-fat cocoa powder and 8% ginger powder had the highest value of total flavonoid content which was 4.68 mg QE/mL of cocoa beverage. The control sample had the lowest flavonoid content which was at a level of 2.46 mg QE/mL of cocoa beverage. Meanwhile, the cocoa beverage formulated with high-fat cocoa powder and 8% ginger powder had the highest value of total flavonoid content which was 3.80 mg QE/mL of cocoa beverage. The control sample had the lowest flavonoid content which was at a level of 1.59 mg QE/mL of cocoa beverage. The biological activity of ginger depends on compounds from the polyphenolic fraction, mainly flavonoids, which has been studied to have anti-cancer activities (Fahmi, 2014). The class of flavonoid compounds in ginger are quercetin, routine, catechins, and epicatechins, which based on research have higher antioxidant activity than ascorbic acid (vitamin C) and tocopherols (vitamin E) (Ghasemzadeh *et al.,* 2010; Oboh *et al.,* 2012). Thus, the addition of ginger powder to cocoa beverages can significantly improve the total flavonoid content of the products.

Table 7. Total flavonoid content of the cocoa beverage samples

Concentration of ginger powder (%)	Total flavonoid content of cocoa beverage formulated with (mg QE/mL of cocoa beverage)		Average
	Low-fat cocoa powder	High-fat cocoa powder	
0 (control)	2.46±0.27	1.59±0.33	2.03±0.54^{A}
2	2.75±0.33	2.17±0.50	2.46±0.50^{B}
4	3.15±0.58	2.76±0.35	2.95±0.50^{C}
6	3.65±0.71	3.77±0.37	3.71±0.55^{D}
8	4.68±0.27	3.80±0.52	4.24±0.61^{E}
Average	3.34±0.90^{a}	2.82±0.97^{b}	

Values are expressed as mean±SD. Values with different lowercase superscript within the same column are significantly different ($p<0.05$). Values with different uppercase superscript within the same row are significantly different ($p<0.05$).

3.7 pH

The pH level of the cocoa beverages with low- and high-fat cocoa powder was in the range 7.68-7.88 and 7.93-8.16, respectively, where the cocoa beverages formulated with high-fat cocoa powder had a higher pH value than those with low-fat cocoa powder (Table 8). According to Muhammad, Gonzalez, Sedaghat Doost *et al.* (2019), the pH value of cocoa beverage is strongly affected by the original pH of the raw material. As expected, cocoa powder with high-fat content tends to have a higher pH value than low-fat cocoa powder as low-fat and high-fat cocoa powder had an initial pH of 7.76 and 8.11, respectively. The addition of ginger powder resulted in a significant decrease in pH values of the cocoa drinks. The results obtained in this study are understandable since the phenolic compounds and organic acids (malic acid and oxalic acid) in ginger are able to release H^+ ions causing a decrease in the pH value (Goh *et al*., 2012).

Table 8. pH measurement of the cocoa beverage samples

Concentration of ginger powder (%)	pH cocoa beverage formulated with		Average
	Low-fat cocoa powder	High-fat cocoa powder	
0 (control)	7.88±0.04	8.16±0.04	8.02±0.15^{A}
2	7.80±0.03	8.13±0.04	7.96±0.18^{B}
4	7.75±0.03	8.04±0.03	7.89±0.16^{C}
6	7.71±0.04	7.98±0.04	7.84±0.14^{D}
8	7.68±0.03	7.93±0.01	7.80±0.13^{E}
Average	7.76±0.08^{a}	8.05±0.09^{b}	

Values are expressed as mean±SD. Values with different lowercase superscript within the same column are significantly different ($p<0.05$). Values with different uppercase superscript within the same row are significantly different ($p<0.05$).

3.8 Determination of consumer preference

The determination of the best formula is carried out using a compensatory model weighting test based on the method of Sullivan *et al.* (2015). The weighting method is largely applied in formula selection because it is considered applicable on samples with many characteristics and is easy to visualize. In this study, the weighting in each parameter was determined based on the results of a survey involving 100 panellists. The value of each test parameter for all samples is shown in Table 9. Not all test parameters are involved to determine the best formula. The parameters of viscosity (cP), sedimentation, antioxidant activity, pH and lightness are involved in the weighting test (Table 10). Based on the results of the panellist survey, the viscosity parameter had the highest rating of the potential to influence the quality of the cocoa beverage. In addition, there were other parameters namely sedimentation, colour and antioxidant content that also contributed to the quality of the product. The viscosity parameter is closely related to consumer acceptance. Meanwhile, sedimentation is one of the determinants of consumer preferences because sedimentation is a common form of physical defects in beverages. In addition to the active compound content, the cocoa beverage functionality can be determined based on antioxidant activity.

The results obtained in the previous survey were then applied as the basis for determining the weight in the compensatory model weighting test. Each parameter applied in selecting the best formula was weighted (VW). The value given for each weighting ranged from 1 -3 depending on the effect on the cocoa beverage sample. In determining the best formula in this study, pH was given a value of 1, colour and antioxidant activity were given a value of 2, while viscosity and sedimentation were given a value of 3. The consideration was because pH had the least effect on the sample, while colour and antioxidant activity had an important influence but not crucial to the sample, and the parameters of viscosity and sedimentation had a crucial influence on the sample. The normal weight (NW) was determined based on the weighted value (VW) divided by the total parameters used (ΣV), which was 5 in the case.

The normalized value (NV) was obtained based on the value of the test parameters produced by a formula (value), the best value of all samples, and the worst value of all samples. The best and worst value of each variable depends on the tendency of the expected test results. In the parameters of colour, viscosity, and sedimentation, it is considered that the lower the average value means the better the sample quality. Therefore, the highest value obtained is the worst score, while the lowest score obtained is the best score. On the contrary, in the parameters of antioxidant activity and pH, the product with a higher value had a higher sample quality. Therefore, the highest value obtained the best score, and the lowest value obtained the worst score.

From the results of the normalized value calculation, the result value (score) was then calculated. Score refers to the final value of each variable calculated from the equation Score = NW × NV. Scores between formulas in each variable show the best formula for a particular variable. The cumulative score result refers to the sum of all scores from all variables, and the highest total score shows the overall best formula. It is shown that the cocoa beverage formulated with low-fat cocoa powder and 8% ginger powder was considered the best formula with the highest total score of 1.54 (Table 10).

4. Conclusion

This research showed that the concentration of ginger powder and fat content of cocoa powder had a significant effect on colour, antioxidant activity, pH, viscosity and sedimentation of cocoa beverage. The best formula of cocoa beverage was found at the sample formulated with low-fat cocoa powder with the addition of 8% ginger powder. The sample had a lightness level of 29.21, an antioxidant activity of 70.5%, total phenolic content of 9.53 mg GAE/mL of cocoa beverage, total flavonoid content of 4.68 mg QE/mL of cocoa beverage, pH of 7.68, the viscosity of 18.53 cP and a sedimentation index of 65. Market research using a hedonic test is

Table 9. Characteristics of cocoa beverages with the variation of concentration of ginger powder and the fat content of cocoa powder

Parameter	F1*	F2*	F3*	F4*	F5*	F6*	F7*	F8*	F9*	F10*	Best Value	Worst Value
Physical Characteristics												
Lightness (L*)	29.78	29.61	29.49	29.32	29.21	28.87	28.80	28.71	28.38	28.22	28.22	29.78
Viscosity	16.27	17.15	17.77	18.23	18.53	16.00	16.75	17.32	17.50	17.92	18.53	16.00
Sedimentation	61.90	62.22	64.44	66.67	65.40	68.89	70.79	71.43	71.75	72.06	61.90	72.06
Chemical Characteristics												
Antioxidant	58.33	61.17	63.17	65.00	70.50	54.50	61.33	61.67	63.17	65.50	70.50	54.50
pH	7.88	7.80	7.75	7.71	7.68	8.16	8.13	8.04	7.98	7.93	8.16	7.68

* Identification of formulations are shown in Table 1.

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Table 10. Determination of the best formula of cocoa beverage with the variation of concentration of ginger powder and the fat content of cocoa powder

Parameter	VW	NW	F1*		F2*		F3*		F4*		F5*		F6*		F7*		F8*		F9*		F10*	
			NV	Score	NV	Score	NV	Score	NV	Score	NV	Score	NV	Score	NV	Score	NV	Score	NV	Score	NV	Score
Physical Characteristics																						
Lightness (L*)	2.00	0.40	0.00	0.00	0.11	0.04	0.18	0.07	0.29	0.12	0.36	0.15	0.58	0.23	0.63	0.25	0.68	0.27	0.90	0.36	1.00	0.40
Viscosity	3.00	0.60	0.11	0.06	0.45	0.27	0.70	0.42	0.88	0.53	1.00	0.60	0.00	0.00	0.30	0.18	0.52	0.31	0.59	0.36	0.76	0.45
Sedimentation	3.00	0.60	1.00	0.60	0.97	0.58	0.75	0.45	0.53	0.32	0.66	0.39	0.31	0.19	0.12	0.07	0.06	0.04	0.03	0.02	0.00	0.00
Chemical Characteristics																						
Antioxidant	2.00	0.40	0.24	0.10	0.42	0.17	0.54	0.22	0.66	0.26	1.00	0.40	0.00	0.00	0.43	0.17	0.45	0.18	0.54	0.22	0.69	0.28
pH	1.00	0.20	0.42	0.08	0.24	0.15	0.14	0.03	0.07	0.01	0.01	0.00	0.99	0.20	0.93	0.19	0.75	0.15	0.62	0.12	0.51	0.10
	11.00	2.20		0.84		1.11		1.19		1.24		1.54		0.62		0.86		0.95		1.07		1.23

*Identification of formulations are shown in Table 1.

important for future study to validate the consumer acceptance of the selected product.

Conflict of interest

The authors declare no conflict of interest.

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