Sensory profile analysis of chocolate drinks using quantitative descriptive analysis (QDA)

Tyas Arie Muktiningrum[1], *Gusti* Fauza[1,*], *Setyaningrum* Ariviani[1], *Dimas R A* Muhammad[1], *Dian Rachmawanti* Affandi[2],

[1]Dept. of Food Science and Technology, Universitas Sebelas Maret, Surakarta, Indonesia
[2]Dept. of Agricultural Product Technology, Universitas Sebelas Maret, Surakarta, Indonesia

Abstract. This study aims to analyse the sensory profile of a low-fat chocolate drink. The chocolate drink is being developed in laboratory of food science and technology department at Universitas Sebelas Maret. The QDA was applied to characterize the sensory profile of the developed product (sample D) and four commercial products (sample A, B, C, and E). 13 panellists were trained to evaluate those samples based on appearance, odour, flavour, basic taste and texture. Further, ANOVA was utilized to differentiate the samples, while PCA and Spider web were applied to analyse the sensory profile of the samples. The results showed that sample D was quite similar to sample A (dominated by cocoa aroma, cocoa flavour, sandiness, undissolved particles, colour, white-cream layer, thickness texture and bitter taste), whereas sample C had similar characteristic to sample E (represented by milky aroma, milky flavour, vanilla flavour and creamy texture). Meanwhile, sample B differed from others for representing malt odour and malt flavour attributes. It is implied from the result that sample A would be the potential competitor for the developed product since they may be in the same market segmentation. Therefore, the strategy of improving the developed product should take a look at the sensory attributes of sample A as a benchmarking.

Keywords: QDA, chocolate drinks, PCA, sensory profile

1 Introduction

Cocoa is one of the major national commodities, the fifth largest production by volume after oil palm, coconut, rubber, and sugar cane [1], and the third largest foreign-exchange earner after oil palm and rubber [2]. Cocoa is a source of polyphenols that have beneficial effects on human health. Some studies suggest the benefits of polyphenols, including their function as antioxidants that neutralize free radicals, anti-inflammatory, and antiproliferation to cancer cells [3].

Cocoa-based products are very popular among various groups of people because of their distinctive taste, aroma, and colour. Today, consumers of chocolate food and drinks are not only dominated by certain groups, but all levels of society. It indicates an encouraging development on the prospects for the chocolate food and beverage market. Nevertheless,

* Corresponding author: gustifauza@staff.uns.ac.id

the current trend is not necessarily focused on the palpability but also on the positive impact of food and beverage on health.

One of the most popular food products is chocolate drinks. It becomes new favourite and has been developed into simple product, such as "instant hot chocolate" and "ready to drink chocolate". A small amount of several active compounds is present in chocolate drinks, including catechins, procyanidin B1 and procyanidin B2 at concentration 0.01 to 0.12% (w/w) [4]. Cocoa beans contain polyphenolic compounds while cocoa products have antioxidant properties, making them potential for being developed into healthy beverage products [5]. According to Al Aribah [6], ready to drink chocolate drink with low-fat cocoa powder and xanthan gum stabilizer has acceptable physical, chemical, and sensory characteristics. Such products are expected to compete and increase the consumption and selling value of Indonesia's processed cocoa exports.

One of the methods to attract consumers' interest is to offer products that fulfil consumers expectation. Research regarding consumer voice to improve food products has been done quite intense by scholars [7-10]. In food product development, evaluating the sensory profile of a product is a crucial step. Descriptive analysis is used to evaluate the sensory attributes of a product and provide information about the intensity of these attributes [11]. One of the most widely used descriptive test methods is quantitative descriptive analysis (QDA). The principle of QDA is based on the ability to train panellists to measure specific attributes of a product and to obtain a comprehensive product description [12]. This method has been widely carried out for the terminology development and quantitative assessment of a food product [13-15]. In the assessment of sensory attributes of a food product, the QDA method is used to assess the attributes of aroma, texture, flavour, taste, and aftertaste of a product [16]. One of the advantages of applying QDA method is its accuracy because the test uses trained panellists. In addition, highly sensitive attributes can also be identified using the QDA method [17].

In this study, an evaluation of the sensory attributes was conducted to a low-fat chocolate drink that developed by the Department of Food Science and Technology Universitas Sebelas Maret (FST-UNS). Characterization was also carried out on four similar products distributed in the markets. The results of the comparison of the sensory profile between the developed product and commercial products can be used as feedback to improve the quality of FST-UNS product in the future.

2 Method

In this study, the characteristic of five samples (A, B, C, D and E) of chocolate drinks were evaluated and analysed. Sample D was the developed product produced by FST-UNS team. The ingredients of the developed product were low fat cocoa powder, refined sugar, non-dairy creamer, corn starch, xanthan gum, and salt. The characteristic of sample D was compared to the similar commercial products from the market (sample A, B, C and E).

The QDA was applied to describe the sensory characteristics of the products through three stages, namely: 1) panellist selection, 2) panellist training, and 3) product testing. Panellist selection aimed to select prospective panellists for testing the product. The selection procedure referred to ISO 8586:2021. This stage was followed by 31 candidates (students from food science and technology department, Universitas Sebelas Maret who have completed sensory analysis course). After conducting pre-screening, acuity tests, and personal interviews, 14 panellists were selected.

Further, the selected panellists joined training that aimed to improve the sensitivity of the panellists against the attributes. During the training, panellists' performance related to discrimination ability, repeatability, and reproducibility were monitored and evaluated. Motivation and input regarding the performance were also given to the panellists through a

graph of the measurement results during the three training sessions. It was conducted to improve the subsequent trainings.

After the training phase, a testing was carried out to describe the chocolate drink attributes as well as to determine their intensity values. The intensity value of each attribute was analysed using ANOVA, Spider Web, and Principal Components Analysis (PCA). ANOVA was used to analyse the differences between samples based on specific attributes, while Spider Web was used to describe the sensory properties of the developed product and the commercial products. Subsequently, PCA was used to analyse the relationship between attributes. It generated a B-plot graph that showed the mapping of product characteristics based on sensory attributes of the samples.

3 Result and discussion

In the selection stage, 14 panellists were selected to participate in the training. One-week training was carried out by using standard ingredients that have similar characteristics to the chocolate drink samples to be tested. Subsequently, focus group discussion (FGD) was conducted to identify the sensory attributes of chocolate drink products. The results are presented in Table 1.

Table 1. Product Sensory Attributes

Attribute	Description
Appearance	
Undissolved particles	Visible particles floating in the drink after stirring
Creaming layer	White cream layer at the top
Color	Brown color intensity
Aroma	
Milky	Fresh milk
Cocoa	Cocoa powder and cocoa (including dark chocolate and milk chocolate)
Vanilla	Sweet vanilla
Malt	Malt/cereal extract
Flavor	
Milky	Fresh milk with a fatty or thick taste
Cocoa	Cocoa powder flavor
Malt	Malt/cereal extract flavor
Taste	
Sweet	Basic taste of sucrose
Bitter	Primary taste characterized by organic acids, phenolic acids, tannins or roasted cocoa
Texture	
Creamy	Fatty mouth coating sensation
Thickness	Watery to thick liquid sensation
Sandiness	Sandy or grainy

From the performance monitoring and evaluating, 13 panellists met the criteria related to discrimination ability, repeatability, and reproducibility. Subsequently, the panellists tested the sensory intensity of the sample based on the attributes listed in Table 1. The test results were analysed using ANOVA to identify the differences between sample as shown in Table 2 (Appendix 1), in which sample D was the developed product.

The appearance attributes presented in Table 2, showing the intensity of the creaming layer of sample D (the developed product) was relatively similar to other samples, while the intensity of the undissolved particles of sample D was similar to sample A. As for colour intensity, sample D had the highest value. Meanwhile, for aroma attributes, sample D had

relatively lower intensity of milky, malt, and vanilla than the other samples, but it had the highest cocoa aroma intensity.

Table 2 illustrated the taste attributes of the samples, showing sample D had the lowest sweet intensity and the highest bitter intensity. For the flavour attributes, sample D had the lowest milky intensity and the highest cocoa flavour. Meanwhile, the intensity of malt flavour was not too different from other samples. For the texture attributes, the creamy intensity of sample D were the same as other samples, but the sandiness and the thickness were the highest.

Numerous studies reported that frequent intake of foods and drinks high in polyphenols is connected with a lower risk of harmful oxidative stress-induced processes in the body [18]. However, polyphenol is responsible for the bitter taste in chocolates and this compound is abundantly found in cocoa-based products, especially dark chocolate [19]. The highest bitter, as well as cocoa aroma intensity in sample D, may indicate a healthier product compared to others. However, for some consumers, the bitter taste may not be preferable. Therefore, reformulation would be needed to improve the sensory properties of the developed product.

The comparison between the intensity of the sensory attributes of sample D and other samples was described using a Spider Web. The results were presented in Fig. 1, showing that among the four commercial samples, sample D had the most similar sensory attributes to sample A which means that sample A is the potential competitor for sample D. Benchmarking on sample A in term of its sensory profile would help developers to improve the developed product.

Furthermore, an analysis of the relationship between attributes and mapping of sample attributes using B-plot on PCA had been carried out (Fig. 2). Consistent with the results of Spider Web, sample A and sample D were in one quadrant, implying that these two samples have similar sensory characteristics, i.e., dominant cocoa aroma and flavour, sandiness, undissolved particles, colour, creaming layer, bitter and thickness. Meanwhile, sample C and sample E were characterized by sweet taste, milky aroma and flavour, dominant vanilla aroma, and creamy texture.

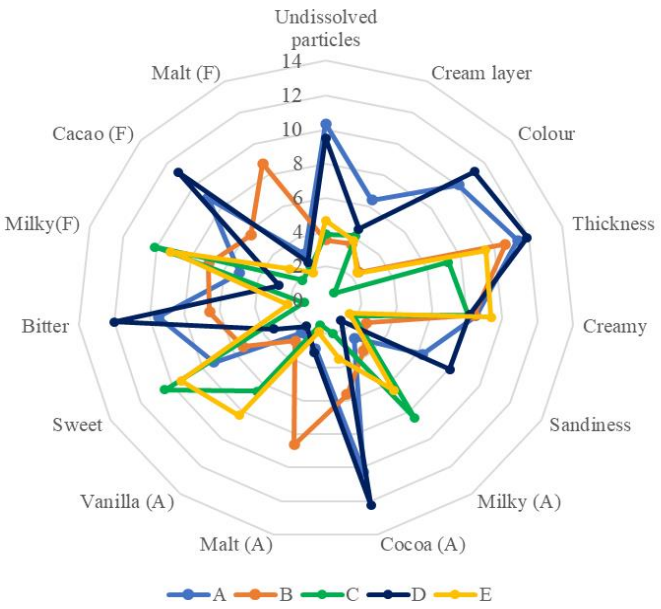

Fig. 1. Sensory profile of the chocolate drinks using spider web diagram

Description of data related to the correlation between the attribute was presented in Table 3 (Appendix 2). Table 3 showed that the attributes of the creaming layer (appearance) and creamy texture were not correlated with other attributes. Meanwhile, bitter taste had positive correlation with colour, cocoa (aroma and flavour), sandiness and thickness, but had negative correlation with milky (aroma and flavour), vanilla aroma, and sweet taste. As expected, sweet taste had positive correlation with milky aroma and flavour but had negative correlation with bitter taste. Further, still from Table 3, sandiness had positive correlation with undissolved particles, colour, cocoa (aroma and flavour), and bitter taste but had negative correlation with milky flavour.

The output of the sensory properties mapping in Fig 1 and 2 as well as the intensity and correlation attribute information from Table 1 and 2 would be beneficial for developers while doing reformulation to improve the sensory quality of the developed product. However, the results of QDA do not give information about which attributes that drive the consumers' liking for the product. Therefore, combining the QDA method with hedonic test using consumers as panellist such as in [20] would be necessary for identifying the most critical characteristics of a product that influence and guide customer desire [21].

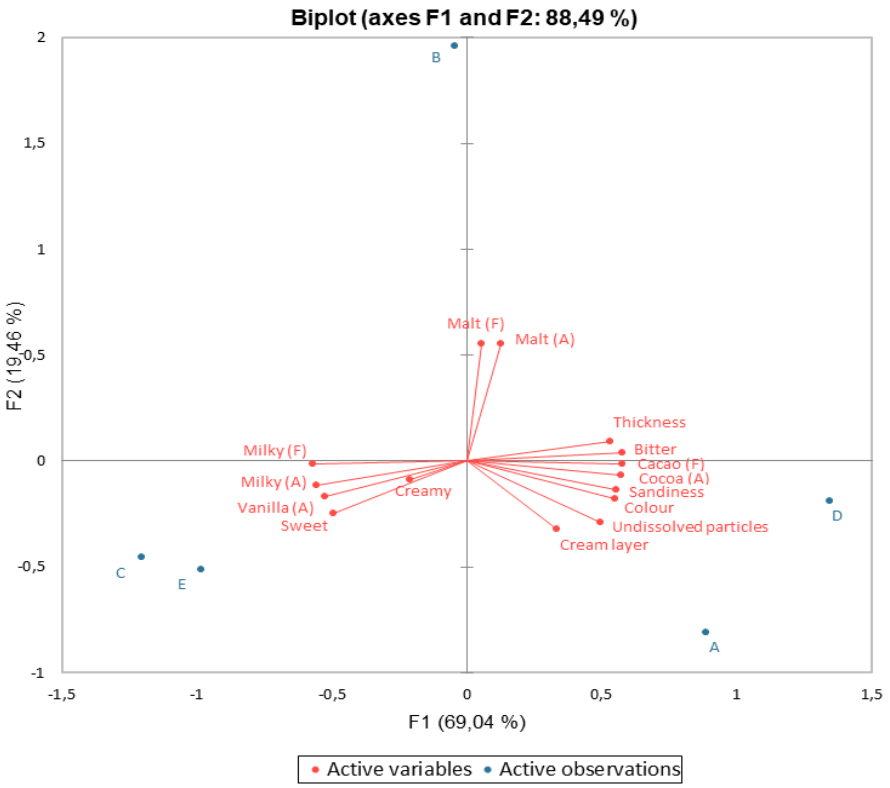

Fig. 2. B-plot of the chocolate drinks and their sensory attributes

4 Conclusion

A sensory profile characterization of five chocolate drink samples using QDA has been done. Fifteen sensory attributes are identified and there are three groups of samples with different sensory profiles. The developed product (sample D) has similar sensory characteristic to sample A, implying that sample A is a potential competitor for the

developed product as they might have similar market. Therefore, the scenario to improve the quality of the developed product should consider the sensory profile of sample A. Moreover, this study characterizes the sensory profile of the chocolate drinks but does not give information regarding customer preferences i.e., which attribute sensory that customers like or dislike. Since this customer preference information is important while developing a product, applying QDA combined with customer preferences would be a potential forthcoming study.

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Appendix 1.

Table 2. Data of attribute intensity of chocolate drinks

Sample	Appearance			Aroma				Taste		Flavour			Texture		
	Undissolved particles	Cream layer	Colour	Milky	Cocoa	Malt	Vanilla	Sweet	Bitter	Milky	Cacao	Malt	Creamy	Sandiness	Thickness
A	10.33 ± 2.43^{b}	6.42 ± 1.18^{b}	10.07 ± 1.69^{c}	2.72 ± 1.89^{ab}	10.27 ± 1.11^{d}	2.87 ± 1.88^{bc}	2.36 ± 2.16^{a}	7.26 ± 1.69^{c}	9.50 ± 1.43^{c}	5.11 ± 2.47^{b}	8.92 ± 1.56^{c}	2.96 ± 2.68^{a}	8.50 ± 1.71^{a}	6.29 ± 1.65^{b}	11.37 ± 0.85^{cd}
B	3.53 ± 1.83^{a}	3.60 ± 2.15^{a}	2.48 ± 1.27^{b}	3.63 ± 2.09^{b}	5.64 ± 2.00^{c}	8.62 ± 1.92^{c}	2.94 ± 2.22^{a}	5.38 ± 1.19^{b}	6.58 ± 1.45^{b}	6.95 ± 2.85^{c}	5.68 ± 1.38^{b}	8.76 ± 1.91^{b}	8.41 ± 2.06^{a}	2.61 ± 1.44^{a}	10.64 ± 1.323^{c}
C	3.87 ± 2.37^{a}	4.13 ± 1.80^{a}	0.63 ± 0.37^{a}	8.52 ± 2.26^{b}	2.00 ± 1.02^{a}	1.45 ± 1.17^{a}	6.58 ± 1.91^{b}	10.47 ± 1.33^{d}	1.25 ± 0.73^{a}	10.13 ± 1.86^{c}	1.77 ± 1.03^{a}	2.16 ± 2.11^{a}	8.08 ± 1.82^{a}	1.82 ± 0.93^{a}	7.25 ± 1.566^{a}
D	9.49 ± 2.16^{b}	4.56 ± 1.73^{a}	11.26 ± 1.42^{e}	1.46 ± 1.22^{a}	12.24 ± 0.65^{e}	3.15 ± 2.70^{ab}	1.86 ± 1.50^{a}	3.36 ± 1.16^{a}	11.97 ± 1.18^{e}	2.79 ± 1.17^{a}	11.21 ± 1.29^{e}	2.45 ± 2.35^{a}	8.12 ± 2.56^{a}	8.06 ± 1.37^{c}	11.92 ± 1.01^{d}
E	4.66 ± 2.22^{a}	3.83 ± 2.40^{a}	2.38 ± 0.64^{b}	6.48 ± 2.58^{c}	3.50 ± 1.51^{b}	1.87 ± 1.47^{ab}	8.31 ± 1.85^{c}	9.42 ± 1.54^{d}	2.16 ± 1.40^{a}	9.21 ± 2.02^{c}	2.77 ± 1.19^{a}	1.77 ± 1.57^{a}	9.36 ± 1.61^{a}	1.52 ± 1.06^{a}	9.46 ± 0.76^{b}

Note: Values followed by different letters indicate a significant difference ($p<0.05$) using the DMRT method

Appendix 2.

Table 3. Pearson correlation value between sensory attributes

Variables	Undissolved particles	Cream layer	Colour	Milky (A)	Cocoa (A)	Malt (A)	Vanilla (A)	Sweet	Bitter	Milky (F)	Cacao (F)	Malt (F)	Creamy	Sandiness	Thickness
Undissolved particles	**1**	0.842	**0.969**	-0.730	**0.902**	-0.270	-0.642	-0.490	0.818	-0.820	0.857	-0.370	-0.198	**0.922**	0.719
Cream layer	0.842	**1**	0.710	-0.432	0.608	-0.306	-0.479	-0.089	0.522	-0.478	0.549	-0.320	-0.154	0.631	0.423
Color	**0.969**	0.710	**1**	-0.860	**0.979**	-0.092	-0.753	-0.688	**0.926**	**-0.935**	**0.954**	-0.217	-0.251	**0.978**	0.839
Milky (A)	-0.730	-0.432	-0.860	**1**	**-0.940**	-0.413	**0.883**	**0.918**	**-0.972**	**0.962**	**-0.957**	-0.278	0.210	-0.852	**-0.982**
Cocoa (A)	**0.902**	0.608	**0.979**	**-0.940**	**1**	0.102	-0.848	-0.818	**0.983**	**-0.986**	**0.995**	-0.029	-0.307	**0.976**	**0.907**
Malt (A)	-0.270	-0.306	-0.092	-0.413	0.102	**1**	-0.486	-0.544	0.271	-0.216	0.185	**0.985**	-0.146	-0.045	0.380
Vanilla (A)	-0.642	-0.479	-0.753	**0.883**	-0.848	-0.486	**1**	0.845	**-0.919**	0.877	**-0.885**	-0.409	0.599	-0.814	-0.787
Sweet	-0.490	-0.089	-0.688	**0.918**	-0.818	-0.544	0.845	**1**	**-0.893**	**0.900**	-0.867	-0.408	0.361	-0.749	-0.866
Bitter	0.818	0.522	**0.926**	**-0.972**	**0.983**	0.271	**-0.919**	**-0.893**	**1**	**-0.994**	**0.996**	0.144	-0.379	**0.945**	**0.923**
Milky (F)	-0.820	-0.478	**-0.935**	**0.962**	**-0.986**	-0.216	0.877	**0.900**	**-0.994**	**1**	**-0.996**	-0.078	0.353	**-0.955**	**-0.919**
Cacao (F)	0.857	0.549	**0.954**	**-0.957**	**0.995**	0.185	**-0.885**	-0.867	**0.996**	**-0.996**	**1**	0.054	-0.357	**0.967**	**0.914**
Malt (F)	-0.370	-0.320	-0.217	-0.278	-0.029	**0.985**	-0.409	-0.408	0.144	-0.078	0.054	**1**	-0.167	-0.165	0.238
Creamy	-0.198	-0.154	-0.251	0.210	-0.307	-0.146	0.599	0.361	-0.379	0.353	-0.357	-0.167	**1**	-0.433	-0.024
Sandiness	**0.922**	0.631	**0.978**	-0.852	**0.976**	-0.045	-0.814	-0.749	**0.945**	**-0.955**	**0.967**	-0.165	-0.433	**1**	0.796
Thickness	0.719	0.423	0.839	**-0.982**	**0.907**	0.380	-0.787	-0.866	**0.923**	**-0.919**	**0.914**	0.238	-0.024	0.796	**1**

Note: Values in bold are different from 0 with a significance level alpha=0.05