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Sensory Characteristics and Consumer Liking of Basil Syrups (*Ocimum basilicum L.*) in Different Sensory Settings

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The objective of this study was to investigate the sensory profiles of basil syrups formulated with different contents of basil leaf extract and sugar, and to determine the key attributes of consumer liking. Moreover, this study also measured consumers' perceptions in two sensory evaluation settings of blind and non-blind (informed) tests. Sixty adult consumers were involved in the evaluation. The basil leaf extract and sugar contents influenced the sensorial characteristic of basil syrups. Moreover, consumers had different perceptions and changed their preferences for this product in different sensory evaluation settings. Information related to ingredients and sugar contents was demonstrated to consumers to enable the shift in their preferences. Consumers perceived the basil syrups as significantly healthier in the non-blind setting (p<0.001) compared to the blind test (p=0.110). Moreover, the liking showed to be significantly higher in the non-blind setting compared to the blind test (p=0.050), especially for the sugar-free samples. This research could be used as a preliminary study to further develop functional drinks made from basil leaves and to consider the information regarding food ingredients provided to consumers.

Key words: blind test, check-all-that-apply, informed test, consumer perception, sugar

INTRODUCTION

The demand for functional food and nutraceuticals increased tremendously during the Covid-19 pandemic [Lestari, 2021], suggesting the shifting of food intake patterns from satisfying hunger to promoting health and wellness [Farzana *et al.*, 2022; Lestari, 2021]. Today, consumers want to take responsibility for their healthcare and well-being, and functional food is aimed to address these specific needs. The development of functional food should involve consumers because they have specific health and nutritional needs [Alongi & Anese, 2021]. Bioactive compounds from plants and traditional herbs frequently become a target for functional food development since these ingredients confer many potential health benefits [Chandrasekara & Shahidi, 2018; Serrano *et al.*, 2018].

Basil (*Ocimum basilicum* L.) is one of the traditional herbs that has the potential to be developed as a functional food product. The plant belongs to the mint family and is indigenous to tropical regions, including Indonesia. *O. basilicum* also well known as wild basil or *Kemangi* in Bahasa Indonesia [Shahrajabian *et al.*, 2020], is an aromatic herb that has been widely used in many cuisines. Basil confers many health benefits and traditionally has been used for the treatment of fever, cough, flu, asthma, and diarrhea [Shahrajabian *et al.*, 2020]. Moreover, the leaves also contain bioactive compounds responsible for their anticancer, radioprotective, antimicrobial, anti-inflammatory, anti-stress, antidiabetic,

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and hypolipidemic effects, and high antioxidant activity [Dhama *et al.*, 2023; Kozlowska *et al.*, 2021; Sestili *et al.*, 2018; Teofilović *et al.*, 2021; Zhan *et al.*, 2020]. The basil leaves have been used broadly in different foods and beverages [Mäkinen & Pääkkönen, 1999; Uzun & Oz, 2021]. Most of the plant's leaves have been used as herbs in meals [Baliga *et al.*, 2016] or consumed as fresh vegetables in mixed salads. The most well-known application of basil leaves is in Italian pesto [Snežana, 2017] while in another study, the leaves were added in cheese to improve taste and aroma [Ribas *et al.*, 2019]. A recent publication utilized basil leaves to increase the antioxidant and acceptance levels in roselle (hibiscus) drinks [Abidoye *et al.*, 2022].

Understanding the key characteristics of a food product is important in order to determine product's acceptability. Moreover, sensory profiles of the products were able to significantly affect consumer acceptability [Chambers, 2019; Topolska *et al.*, 2021]. The appearance, texture, flavor, taste, aroma and even sound of foods can impart a desire to eat and promote liking [Chambers, 2019]. In addition, there was a strong and positive correlation between sensory profiles and consumption of functional food products, suggesting that taste and aroma play a significant role in determining consumer acceptability of a new functional food [Urala & Lähteenmäki, 2004].

Sensory descriptive analysis can be used to distinguish sensory characteristics of specific food and highlight their differences [Marques *et al.*, 2022; Yang & Lee, 2019], whereas consumer research can be deployed to identify factors that affect food acceptability [Ruiz-Capillas & Herrero, 2021]. The main objective of this study was to identify the sensory characteristic of syrups made from *O. basilicum* leaves and the key consumer liking drivers using the check-all-that-apply (CATA) method. In addition, two methods of consumer testing, *i.e.*, comparing blind test (without any information provided, coded samples) and non-blind test (with information regarding the samples, non-coded samples) were applied in this study. This was aimed to evaluate consumer perceptions and preferences in an informed setting. Based on previous literature, consumers were shown to have different perceptions towards foods in blind and non-blind settings, demonstrating that information may be able to influence their preferences [Bemfeito *et al.*, 2021; Fibri & Frøst, 2020; Mazhangara *et al.*, 2022]. This is the first study to investigate the sensory characteristics and the key driver of consumer liking of basil syrups in different formulations and at the same time evaluate consumers' perceptions in the different sensory evaluation settings (blind *vs.* non-blind test).

MATERIALS AND METHODS

Preparation of the basil syrups

The syrups were made using fresh basil leaves (purchased in Sekolah Seniman Pangan, Javara Indonesia), sugar, and water as the main ingredients. The main formulation had followed the previous study with modification [Pratama *et al.*, 2013]. The first step was to make a sugar solution by adding caster sugar (100 g) and water in a 1:1 (*w/v*) ratio. The solution was then mixed and boiled until the sugar dissolved. The second step was to make the basil extract by blending the chopped basil leaves (100 g) using an HR2223 blender (Philips, Jakarta, Indonesia) with water in a 1:1 (*w/v*) ratio for 2 min and filtering the mixture using a stainless-steel filter mesh (20 mesh, BZ Wire Mesh Products Co., Anping, China) to separate the liquid (extract) and the sediment. The basil extract was then heated until it reached 100°C for around 2 min and blended with the syrup solution in various proportions. The basil syrups were then placed in sterilized glass jars for the cooling process. Afterwards, they were sealed and packaged in closed 10-mL disposable cups to be evaluated by consumers. Before evaluation, the samples were stored at ambient temperature.

This study evaluated the different addition levels of basil leaf extract to the syrup solution, *i.e.*, 5%, 10%, 15% and 20% (*v/v*) (samples F1, F2, F3 and F4, respectively). In addition, three alternative sugar versions were analyzed, including: 10% (*v/v*) of basil extract with 50% sugar reduction (the sugar portion (50 g) was replaced with 4 g of steviol glycosides (Stevia, Tropicana Sweetener, Nutrifood, Cikarang, Indonesia) (sample F5), 10% (*v/v*) of basil extract with no added sugar (100% sweeteners; the sugar portion (100 g) was replaced with 8 g of steviol glycosides) (sample F6), and 10% (*v/v*) of basil extract with the addition of 50 g of honey (Madurasa, Natural Honey, Banten, Indonesia) instead of sugar (sample F7). All formulations were presented in Table 1. Three batches were prepared for each of the formulations.

Table 1. Formulations of basil syrups.

Syrup code	Content of basil extract in syrup	Composition of sweetening ingredients of the syrup
F1:5%	5% (*v/v*)	100% sugar
F2:10%	10% (*v/v*)	100% sugar
F3:15%	15% (*v/v*)	100% sugar
F4:20%	20% (*v/v*)	100% sugar
F5:10%+SR	10% (*v/v*)	50% sugar reduction (SR) (replaced by sweetener (SWE) – steviol glycosides)
F6:10%+SWE	10% (*v/v*)	Sugar 100% replaced by SWE – steviol glycosides
F7:10%+HN	10% (*v/v*)	Sugar 100% replaced by honey (HN)

Determination of CATA method attributes

All the attributes were generated and discussed during the focus group discussion (FGD) session by eight trained panels (5 women and 3 men, mean age: 28.6 years) from the Food Technology Department, Bina Nusantara University, Jakarta, Indonesia. Each of the panelists was served all the samples and asked to write all the sensations that they perceived [Ervina *et al.*, 2020]. In addition, raw basil leaves, sugar, lemongrass, mint, honey, fresh cut lemon, fresh cut grass, and raw leafy vegetables were also presented as the references to confirm the perceived sensation from the samples. The similar attributes generated by panelists were then grouped together (*i.e.*, thin, watery, water-like and water merged as thin). The CATA questions for the non-sensory attributes were adapted from the previous study [Kim *et al.*, 2013].

Procedures in consumer tests

In total, 60 untrained panelists participated in this study (50% men and 50% women, mean age: 24.5 years). Prior to the tests, an introduction regarding the study was explained and the digital consent forms were collected by asking the respondents to thick the "agreed" box in the online questionnaire if they were willing to participate. In addition, a verbal consent was also asked at the beginning of the evaluation, all the participations was voluntary. The list of the ingredients used in the samples were provided to the consumers at the beginning of the test to avoid recruiting someone with food allergies or dietary restrictions with one of the ingredients. The participants were also informed that all the data and information collected will be processed and stored as anonymous. The study has been approved by the ethical committee of the Research and Technology Transfer Office (RTTO), Bina Nusantara University, Jakarta, Indonesia (referral code: 60/VR.RTT/IV/year 2022) and has followed the World Medical Association (WMA) declaration of Helsinki [WMA, 2013].

The tests were divided into two parts. The first part was the blind test, all the samples were coded in a three-digit--random number and served monadically to the participants in a random order. The second part was the non-blind test, the participants were provided with the information regarding the samples (*i.e.*, the ingredient list, sugar content such as 100% sugar, 50% reduced sugar, no sugar added or replaced with sweetener and honey). Noteworthy is that the consumers had no information that the first and second part was actually evaluating the same samples. The blind test evaluated all the samples presented in Table 1. This evaluation included the overall liking and all the CATA attributes, while the non-blind test evaluated only samples F2, F5, F6 and F7 and focused on evaluating the overall liking and the non-sensory attributes only. Consumer liking was measured using a 9-point hedonic scale and was always evaluated first followed by the CATA questions. The participants were asked to tick the attribute (check-all-that-apply) if it was perceived in the sample [Piochi *et al.*, 2021; Tarancón *et al.*, 2020]. They were also asked to rinse their mouth with water before tasting and in between sample tasting. A short break for around two minutes was provided to ensure all the sensation from the previous sample had vanished before the participants continued to the next sample. The results of CATA questions were expressed as percentage of frequency of perception of each attribute by consumers.

Statistical analysis

The CATA results were analyzed using Cochran's Q test [Galler *et al.*, 2020]. The attribute with a significant difference ($p \leq 0.05$) was then further analyzed using McNemar-Bonferroni test. The correspondence analysis was employed to map the associations between the attributes and the samples. In addition, the penalty analysis was conducted to evaluate which attributes significantly impacted liking. To evaluate the differences between the blind and the non-blind test setting on liking, a Student's *t*-test was conducted. All the data was analyzed using XLSTAT Sensory version (Addinsoft, Paris, France, Version 2019.2.2).

RESULTS AND DISCUSSION

Sensory characteristics of the basil syrups

Thirty-two attributes of basil syrups were determined and used in the CATA method. They consisted of 3 visual attributes, 9 aromas, 10 tastes, 2 textures and 8 non-sensory attributes. The complete attributes are listed in Table 2. CATA can incorporate both sensory and non-sensory properties such as emotion or feeling when consumers tasted the products or the perception related to price, usage occasions, and product positioning [Ruiz-Capillas *et al.*, 2021; Varela & Ares, 2012], which makes this method very consumer oriented. CATA method has been reported as a valid method to discriminate products' characteristics using untrained panel or consumers [Tarancón *et al.*, 2020].

The frequency of consumer-perceived CATA sensory attributes of each basil syrup recipe in a blind test is presented

Table 2. Check-all-that-apply (CATA) attributes.

Visual	Aroma	Taste	Texture	Non-sensory
Light green	Sweet	Sweet	Thick (viscous)	Fresh
Dark green	Bitter	Bitter	Thin (watery)	Innovative
Transparent	Basil	Umami (savory)		Herbal drink
	Lemongrass	Basil		Traditional drink
	Sour, citrus	Lemongrass		Calming
	Earthy	Sour, citrus		Healthy drink
	Grassy	Earthy		Vegetables
	Mint	Grassy		Sugary drink
	Honey	Mint		
		Honey		

in Table 3. For the texture attribute, most of the samples had thin and watery-like characteristic with F6 having the most watery texture (perceived by 100% of the participants) followed by F5 (90% of the participants). F6 is the formula of basil syrup without any sugar addition (replaced by sweetener), while F5 is the formula with 50% sugar reduction (substitute with sweetener). In beverages, sugar is not only used to sweeten taste but also to improve texture and mouthfeel [Wagoner *et al.*, 2018], therefore reducing or replacing sugar with sweetener will decrease the viscosity of the syrups.

For the color attributes, F7 (formulation with honey) appeared to be the most transparent and did not have dark green color (Table 3). The green color of basil may be covered with the yellow-to-dark amber color from honey [Aparna & Rajalakshmi, 1999]. The addition of basil extract at 10–20%, *v/v* (F2, F3, and F4) significantly increased the dark green color of the syrup, this may be due to the chlorophyl content of the basil leaves [Dadan *et al.*, 2021]. Interestingly, the dark green color was significantly less perceived when the sugar content was reduced or replaced by sweetener in F5 and F6, respectively. These phenomena can be explained due to the formation of sugar degradation product due to the heating process in the sample making [Hubbermann *et al.*, 2006]. The more sugar added in the formula enhanced the formation of the sugar-degradation product. This condition will contribute to the darker color of the final product [García *et al.*, 2017].

The basil aroma was perceived by more than 50% of the consumers in most of the formulations except for F7 (honey) and this trend was similar for the basil taste (Table 3). The taste and aroma of grassy were perceived high in the sample with 20% (*v/v*) addition of basil extract (F4). The *cis*-3-hexanal is abundant in green plants, including basil, and this aromatic compound contributes to the fresh-cut grass aroma or grassy odor [van Nieuwenburg *et al.*, 2019]. Interestingly, the taste and aroma of lemongrass

Table 3 The frequency of perception by consumers (%) of the sensory check-all-that-apply (CATA) attributes of the basil syrups with different contents of basil extract and sugar.

Attributes	F1:5%	F2:10%	F3:15%	F4:20%	F5:10%+RS	F6:10%+SWE	F7:10%+HN
Thin watery	61.7^{cd}	45.0^{d}	46.7^{d}	40.0^{d}	90.0^{ab}	100.0^{a}	80.0^{ab}
Thick viscous	38.3^{ab}	55.0^{a}	53.3^{a}	60.0^{a}	10.0^{cd}	0.0^{d}	20.0^{bc}
Light green	45.0^{b}	8.3^{cd}	1.7^{d}	5.0^{cd}	80.0^{a}	43.3^{b}	25.0^{bc}
Dark green	50.0^{b}	90.0^{a}	95.0^{a}	91.7^{a}	11.7^{c}	10.0^{c}	0.0^{c}
Transparent	5.0^{c}	1.7^{c}	3.3^{c}	3.3^{c}	8.3^{c}	46.7^{b}	75.0^{a}
Aroma sour/citrus	13.3^{b}	5.0^{b}	20.0^{ab}	8.3^{b}	26.7^{ab}	21.7^{ab}	51.7^{a}
Aroma honey	8.3^{b}	3.3^{b}	8.3^{b}	11.7^{b}	3.3^{b}	5.0^{b}	46.7^{a}
Aroma mint	6.7^{a}	8.3^{a}	3.3^{a}	10.0^{a}	5.0^{a}	5.0^{a}	16.7^{a}
Aroma basil	56.7^{b}	73.3^{ab}	80.0^{a}	76.7^{ab}	65.0^{ab}	56.7^{b}	28.3^{c}
Aroma sweet	46.7^{a}	31.7^{ab}	30.0^{ab}	25.0^{ab}	20.0^{b}	16.7^{b}	35.0^{ab}
Aroma grassy	25.0^{ab}	28.3^{ab}	21.7^{ab}	41.7^{a}	26.7^{ab}	31.7^{a}	6.7^{b}
Aroma bitter	0.0^{a}	6.7^{a}	1.7^{a}	3.3^{a}	8.3^{a}	15.0^{a}	1.7^{a}
Aroma lemongrass	30.0^{a}	40.0^{a}	30.0^{a}	36.7^{a}	21.7^{a}	21.7^{a}	21.7^{a}
Aroma earthy	1.7^{a}	6.7^{a}	8.3^{a}	11.7^{a}	6.7^{a}	15.0^{a}	8.3^{a}
Taste sour/citrus	13.3^{ab}	5.0^{b}	6.7^{b}	8.3^{ab}	6.7^{b}	11.7^{ab}	26.7^{a}
Taste honey	28.3^{bc}	35.0^{b}	35.0^{b}	21.7^{bc}	36.7^{b}	11.7^{c}	81.7^{a}
Taste mint	5.0^{a}	11.7^{a}	6.7^{a}	18.3^{a}	6.7^{a}	3.3^{a}	8.3^{a}
Taste basil	41.7^{ab}	56.7^{ab}	63.3^{a}	60.0^{a}	53.3^{ab}	26.7^{bc}	15.0^{c}
Taste sweet	91.7^{a}	88.3^{a}	85.0^{a}	80.0^{ab}	83.3^{ab}	56.7^{b}	71.7^{ab}
Taste grassy	6.7^{a}	11.7^{a}	20.0^{a}	23.3^{a}	13.3^{a}	26.7^{a}	8.3^{a}
Taste bitter	0.0^{b}	1.7^{b}	3.3^{b}	1.7^{b}	10.0^{b}	73.3^{a}	10.0^{b}
Taste lemongrass	23.3^{a}	20.0^{a}	18.3^{a}	16.7^{a}	16.7^{a}	15.0^{a}	8.3^{a}
Taste earthy	0.0^{a}	1.7^{a}	3.3^{a}	3.3^{a}	0.0^{a}	11.7^{a}	3.3^{a}
Taste umami/savory	1.7^{a}	3.3^{a}	5.0^{a}	3.3^{a}	3.3^{a}	5.0^{a}	3.3^{a}

Different letters in row showing significant differences based on McNemar-Bonferroni test ($p \leq 0.05$). SR, sugar reduction; SWE, sweetener; HN, honey. Syrup codes and their formulations are detailed in Table 1.

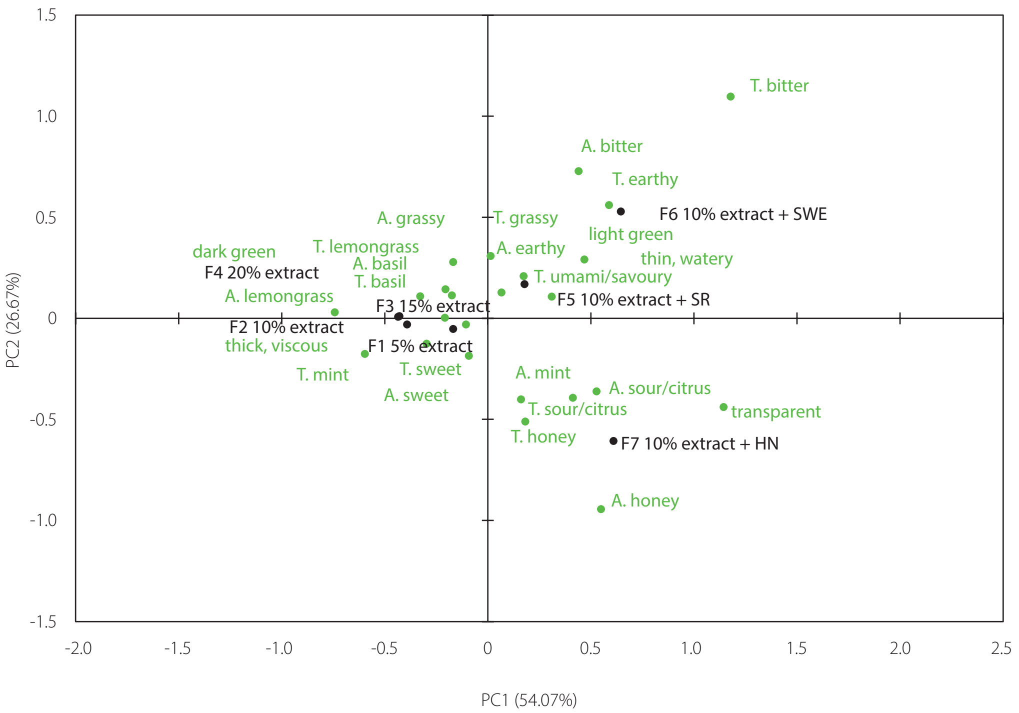

Figure 1. Plot of correspondence analysis of sensory attributes of basil syrups with different contents of basil extract and sugar. SWE, sweetener; SR, sugar reduction (50% sugar); HN, honey; A, aroma; T, taste. Syrup codes and their formulations are detailed in Table 1.

was also perceived in most of the samples, indicating that basil leaves contain similar odorants with lemongrass, such as linalool (contributes to floral and sweet notes), citral (lemon, citrus, sour), and myrcene (spices) [Patel *et al.*, 2021; Skaria *et al.*, 2006]. The bitter taste was perceived as extremely high in F6 (100% sweetener). The addition of sweetener to fully replace sugar in F6 may result in bitter note and bitter aftertaste of the basil syrups. Steviol glycosides were used as sweeteners in this study. This class of compounds has been reported to provide a strong bitterness intensity and bitter aftertaste [Hellfritsch *et al.*, 2012; Tao & Cho, 2020]. The stevia compounds were selected in this study because they are the natural-non-caloric sweetener and well-known by consumer [Tao & Cho, 2020]. The bitterness of steviol glycosides became the main challenge of food industries to use stevia as a non-nutritive sweetener [Hellfritsch *et al.*, 2012; Tian *et al.*, 2022]. Sweetness was perceived in most of the basil syrup samples except for F6. The sweetness intensity in F6 may be covered by the lingering bitter taste sensation from stevia and this may reduce the sweetness sensation [Tian *et al.*, 2022].

The sensory characteristics of each formulation were also mapped in a symmetric plot and presented in Figure 1. The two principal components of PC1 and PC2 contributed to 81% of variability. Based on the CATA mapping, the sensory profile between F1 (5% extract, *v/v*), F2 (10% extract, *v/v*), F3 (15% extract, *v/v*) and F4 (20% extract, *v/v*) lies on a similar group and in proximity. These samples were characterized with taste and aroma of sweet, lemongrass, basil, and dark green color. Moreover, samples made with 100% sugar (F1, F2, F3, and F4) lay on left quadrants and were separated with the samples made with sweetener or honey (F5, F6, and F7) which lay on right quadrant based on PC1. In addition, F5 and F6 were also separated with F7 based on PC2. Based on the mapping, F5 and F6 were associated with thin, watery, bitter aroma and bitter taste, while F7 was closely related to taste and aroma of citrus, honey, and was transparent in color. The sensory profiles of each formula presented in the mapping from Figure 1 were in line with what was described based on data in Table 3.

Blind test *vs.* non-blind test: Impact on consumers' perception and liking

This study also investigated the consumer perception for non-sensory attributes and their liking in different settings of blind test and non-blind test. Based on Cochran's Q test (Table 4), "healthy drink" was perceived as an important attribute in the non-blind test (p<0.001) but not in the blind test evaluation (p=0.110). Sugar content in the basil syrups may relate with health perceptions, because sugar is commonly associated with metabolic diseases such as diabetes, overweight and obesity [Reis *et al.*, 2017]. The consumers were informed regarding the sugar content of the samples (reduced sugar, replaced by sweetener, honey) in the non-blind test. The disclosure of health-related information of a product could significantly increase the willingness of consumers to try and to buy a product, and this information could positively modulate consumer perception [Grasso *et al.*, 2017]. In the case of sugar content, consumers may think that the sugar-reduced and the sugar-free version of the basil syrup is associated with healthiness, such as diabetes prevention, reduced calorie intake, and prevention of overweight and obesity, and thus able

Table 4. Cochran's Q test *p*-values for the non-sensory check-all-that-apply (CATA) attributes of the basil syrups in the blind test and non-blind test.

Attribute	Blind test	Non-blind test
Fresh	0.009	<0.001
Innovative	0.887	0.402
Herbal drink	<0.001	<0.001
Traditional drink	0.002	0.003
Calming	0.427	0.172
Healthy drink	0.110	<0.001
Vegetable	0.029	0.036
Sugary drink	<0.001	<0.001

to positively impact consumers perception and their acceptability [Reis *et al.*, 2017; Wardy *et al.*, 2018].

Table 5 presents the consumer perception for the non--sensory attributes in the blind and non-blind test of each basil syrup formula. The "healthy drink" attribute was perceived as significantly higher in the non-blind testing compared to the blind test, especially for the samples with sugar reduction (F5), no sugar (F6) and honey (F7). Sugar reduction has been closely correlated with health status as the WHO suggests to reduce sugar intake by less than 10% of the total dietary intake with a further reduction of 5% providing additional health benefits [Deliza *et al.*, 2021; WHO, 2015]. Moreover, previous studies have reported the association between sugar reduction and consumer perceptions [Deliza *et al.*, 2021; de Souza *et al.*, 2021; Wardy *et al.*, 2018] showing that consumers will provide positive attitude and prefer sugar-reduced or sugar-free version for health reasons. However, the perception of "sugary drink" was similar in both settings. We assume this could be influenced by the texture of the basil syrups. In the blind test, consumers already perceived the sugar-free samples as less sugary even though they had no information regarding the sugar content. The sugar-free version was characterized as thin, watery and having bitter taste, thus this might have influenced consumers perception regarding the sugar levels [Wagoner *et al.*, 2018].

The information provided to the consumers before the test could influence their perception to the product directly. For example, the information regarding coffee quality before tasting was reported to significantly increase consumers preferences [Bemfeito *et al.*, 2021]. Moreover, another study suggests that the nutritional information, such as sugar content, was able to influence consumer perception regarding physical health and emotional aspects of wellbeing [Reis *et al.*, 2017]. The same study also showed that consumer perception was significantly changed when they were provided information regarding the sugar content of the juice, in which consumers preferred juice without added sugar (sugar-free) [Reis *et al.*, 2017]. The use of sweetener is associated with less calorie foods, and consumers may have expectation that this product will provide health benefits [Deliza *et al.*, 2021; Wardy *et al.*, 2018].

The hedonic aspect was also evaluated to compare the liking score of the basil syrups in the blind and the non-blind setting. Based on the Student's *t*-test, the liking showed to be significantly higher (p=0.050) for the basil syrup with sweetener (no added sugar) in the non-blind test (mean liking score 4.72) compared to the blind test (4.03), while there were no significant differences for the other samples (Table 6). In addition, the results of the penalty analysis for the non-sensory attributes were different in the blind test and the non-blind test. The mean impact is presented in Table 7. The results show that "sugary drink" positively affected consumer liking in the blind test but not in the non-blind test setting. Moreover, "fresh", "innovative" and "healthy drinks" were able to significantly promote liking while "herbal drink" was found to decrease liking in the non-blind test. However, the results were different in the blind testing, as only the "sugary drink" positively impacted liking. The non-nutritive sweetener used in the syrup formulation may provide a "healthy" perception for consumers. Based on the penalty analysis, the "healthy drink"

Table 5. The frequency of perception by consumers (%) of non-sensory check-all-that-apply (CATA) attributes of basil syrups in the blind test and non-blind test.

Attribute	Blind test				Non-blind test			
	F2:10%	F5:10%+SR	F6:10%+SWE	F7:10%+HN	F2:10%	F5:10%+SR	F6:10%+SWE	F7:10%+HN
Fresh	16.7^{b}	10.0^{b}	6.7^{b}	25.0^{ab}	21.7^{ab}	11.7^{b}	8.3^{b}	38.3^{a}
Innovative	26.7^{a}	26.7^{a}	26.7^{a}	30.0^{a}	28.3^{a}	35.0^{a}	25.0^{a}	33.3^{a}
Herbal drink	25.0^{b}	18.3^{b}	58.3^{a}	33.3^{ab}	26.7^{ab}	15.0^{b}	51.7^{a}	35.0^{ab}
Traditional drink	3.3^{a}	5.0^{a}	21.7^{a}	8.3^{a}	6.7^{a}	6.7^{a}	26.7^{a}	18.3^{a}
Calming	11.7^{a}	6.7^{a}	6.7^{a}	13.3^{a}	15.0^{a}	10.0^{a}	5.0^{a}	16.7^{a}
Healthy drink	13.3^{b}	18.3^{b}	26.7^{b}	26.7^{b}	13.3^{b}	33.3^{a}	45.0^{a}	48.3^{a}
Vegetable	20.0^{a}	10.0^{a}	18.3^{a}	5.0^{a}	11.7^{a}	15.0^{a}	18.3^{a}	3.3^{a}
Sugary drink	75.0^{a}	76.7^{a}	30.0^{b}	41.7^{b}	85.0^{a}	66.7^{a}	28.3^{b}	31.7^{b}

Different letters in row show significant differences based on McNemar-Boferroni test ($p \leq 0.05$). SR, sugar reduction; SWE, sweetener; HN, honey. Syrup codes and their formulations are detailed in Table 1.

Table 6. Consumers' liking in the blind and non-blind test.

Samples	Blind test	Non-blind test	*p*-Value
F2:10%	6.38±1.49	6.12±1.35	0.308
F5:10%+SR	5.35±1.44	5.70±1.37	0.174
F6:10%+SWE	4.03±1.97	4.72±1.79	0.050
F7:10%+HN	5.93±1.72	6.17±1.64	0.448

p-Value was calculated based on Student's *t*-test. SR, sugar reduction; SWE, sweetener; HN, honey. Syrup codes and their formulations are detailed in Table 1.

Table 7. Results of penalty analysis in the blind test and non-blind test.

Attribute	Blind test		Non-blind test	
	Mean impact	*p*-Value	Mean impact	*p*-Value
Fresh	1.18	0.285	1.24	<0.001
Innovative	0.25	0.359	0.47	0.043
Herbal drink	−0.47	0.065	−0.48	0.036
Traditional drink	−0.85	0.170	0.05	0.224
Calming	1.12	0.121	1.26	0.554
Healthy drink	0.43	0.146	0.43	0.050
Vegetable	0.05	0.740	−0.57	0.441
Sugary drink	0.54	0.026	0.19	0.377

attribute significantly (p=0.050) influenced liking (mean impact of 0.43). This may promote consumer acceptability towards the samples since a non-nutritive sweetener is associated with non-caloric food and sugar intake reduction [Deliza *et al.*, 2021] as well as weight and diabetes management [Farhat *et al.*, 2021; Lohner *et al.*, 2017], which is closely related with healthiness aspect. The liking of basil syrups was influenced by the different attributes in the blind test and the non-blind test, suggesting that consumer perception can be modulated by the information provided prior to testing.

Our study found that the drivers of liking for non-sensory attributes were different when comparing the blind and the non--blind test evaluation. The information provided to consumers prior to tasting can influence their perception and liking. Our study corroborates previous studies [Bemfeito *et al.*, 2021; Fibri & Frøst, 2020; Henrique *et al.*, 2015; Mazhangara *et al.*, 2022] that also found similar results in comparing consumers perception in the blind and the non-blind setting. For example, information regarding the label of organic foods was able to influence consumers' perception of the products and increase their purchase interest [Asioli *et al.*, 2018]. Further, information regarding coffee quality was shown to change consumer preferences and increase their liking significantly compared to the blind testing [Bemfeito *et al.*, 2021]. A similar result was also reported for sausages [Mazhangara *et al.*, 2022] and cooked ham [Henrique *et al.*, 2015], suggesting that the information obtained regarding the samples (ingredients, processing, origin) in a non-blind setting can shift consumer perception and preferences. A previous study reported that when consumers were presented with information regarding salt-reduction in the biscuit samples their liking was higher compared to a normal-salt biscuit [Vazquez *et al.*, 2009]. However, when the same biscuits were tested in the blind test setting the liking was similar between normal-salt and reduced-salt biscuit. Sensory and non-sensory cues may interact to build consumer perception, and the interaction between these cues depends on such factors as the product characteristics, familiarity, brand, sensory profiles, prices or any additional claim related to health and wellness [Carrillo *et al.*, 2012], which can influence consumer preferences.

CONCLUSIONS

This study investigated the sensory profiling of basil syrups with different contents of basil extract and different sugar formulations using the CATA method. The different addition levels of basil extracts significantly impacted the sensory profiles of the basil syrups. Moreover, the sugar content was found to significantly modify sensory profiles of the samples. Interestingly, the consumer perception of the basil syrups showed to be different in the blind and the non-blind testing. The information provided in the non--blind sensory evaluation setting may be able to change consumer preferences of the basil syrup. There was a shift for the key liking attribute from "sugary drink" in the blind testing into "fresh", "innovative" and "healthy drink" in the non-blind testing. This concludes that information provided to consumers can modulate their perception and liking. Our study also suffers from some limitations.

We suggest involving more participants with a wider age group for next studies to confirm the finding. To date, this is the first study that investigates sensory profiles of basil syrups using CATA method and the results could be used as a preliminary study to develop healthy beverages made from basil with consideration of healthy information provided to consumers.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

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