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Article

Exploring the impact of logo colors on the perceived tastes of tea beverages—A study on hand-shaken beverages in Taiwan

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Abstract: Color visually communicates the product's flavors to consumers and further influences their taste perception. This study explores the perceived taste of tea beverages caused by the logo's principal colors, using hand-shaken tea beverages in Taiwan as an example. To identify the linkage between the logo color and tea tastes, this study divides the taste of tea beverages into four categories: sweetness, freshness, bitterness, and astringency. Then, the 69 tea beverage logos are allocated into the 14 color sections in the CIELAB color space according to their primary colors. The Correspondence Analysis method is employed to visualize the relationships between the logos and the perceived tastes. The tea tastes are then mapped into the color sections in the CIELAB color space. The analysis results reveal that the sweetness links to logos in the Warm Scheme colors (hue angle from 0 to 59 degrees). The fresh taste is bound with the logo with the Cool White Scheme colors (hue angle from 90 to 149 degrees and brightness >80). Finally, the bitter and astringent tastes link to the logo colors in the Cold Black Scheme colors (hue angle from 60 to 89 degrees, 150 to 329 degrees, and brightness <25). This study expands the color and taste association literature from general food to tea beverages. Our obtained empirical results can be applied to hand-shaken beverage companies to select principal colors for designing logos and packages that align with tea beverages' perceived tastes to convey brand recognition accurately.

Keywords: logo color; perceived taste; hand-shaken beverage; correspondence analysis

1. Introduction

The Taiwanese hand-shaken tea beverage industry is a fiercely competitive market. Taiwanese unique tea leaves and culinary techniques create distinctive flavors and appearances, such as bubble and fresh milk tea. The industry has flourished in the domestic market and successfully exported its regional characteristics overseas, becoming a significant representative of Taiwanese culinary culture.

Color is one of the main non-information factors influencing consumer behavior (Delwiche, 2012; Krugman, 1966; Meyers-Levy and Peracchio, 1995; Singh, 2006; Veflen et al., 2023; Velasco et al., 2016). Among its psychological functions, color visually communicates the product's flavors to consumers (Jin et al., 2019; Lick et al., 2017; Sakarya and Dortyol, 2022; Spence, 2016) and influences their taste perception (Sheibani et al., 2019; Song and Yang, 2023). "The first taste is always through the eyes," as van der Laan et al. (2011) stated. Since taste is a crucial factor influencing food choices (Li et al., 2020), companies must choose colors in logos or

packages that correctly convey their products' taste characteristics and positioning.

Most previous studies focused on the correlation between color and the basic tastes of food, such as Wan et al. (2014), O'Mahony (1983), Heller (1999), Lick et al. (2017), and Raevskiy et al. (2022). However, more research needs to be conducted on the perceived tastes induced by colors in the tea beverage industry. This study contributes to the gap by exploring the associations of logo colors with the perceived tea tastes by taking Taiwan's hand-shaken tea beverage industry as an example.

According to their primary color, the study allocated 69 logos into 14 non-overlapped color sections in the CIELAB color space. Five hundred twenty-one responses to the questionnaire were used for the Correspondence Analysis to visualize the relationship between the logo colors and the four perceived tastes: sweet, fresh, bitter, and astringent. The results reveal that the 69 logos are clustered into three taste groups. The sweet group links to logos in 2 color sections. The fresh group ties to logos in 3 color sections. Last, the bitter and astringent tastes correlate to logos in 8 color sections.

The remaining paper is organized as follows. Section two reviews the literature on perceived flavors induced by the colors. Then, the research design section presents the production of the tea drink brand logos for the questionnaires and the questionnaire design. Next, the third section analyzes the relationship between the colors and the expected tea tastes based on the collected data. After that, this paper discusses the findings in the fourth section. Lastly, the conclusion is provided.

2. Literature review

Colors influence the consumer's purchase decisions as they impact their sensations and perceptions (Elliot and Maier, 2014; Singh and Srivastava, 2011). Panigyrakis and Kyrousi (2015) indicated that color as a visual language is the sensory with the highest information capacity of the five human senses. Colors can increase appetite, comfort emotions, and enhance mood (Sajid Rehman Jr et al., 2021; Singh, 2006). The customer's affective responses to visual features are established through associative learning from life experiences (Higgins and Hayes, 2019; Spence and Van Doorn, 2022; Yu et al., 2018).

The colors on the logos and packages impact consumer expectations and perceived tastes and further influence their purchasing intentions (Kunz et al., 2020; Lick et al., 2017). The visual cues make healthy food more attractive and can convey the concepts of health and low-fat nutrients (Garber Jr et al., 2001). Red-packaged products are perceived to be sweeter, whereas products packaged in green and blue are associated with the perception of healthiness (Huang and Lu, 2015). Packaging designs with a midrange color temperature on beverage bottles evoke higher positive emotions (Wang et al., 2010). Color combinations with similar hues elicit higher positive emotions, while contrasting colors produce a lower emotional impact regarding bottle packaging. Besides influencing taste perception, color in packaging also affects consumers' visual search. The color-flavor incongruence slows the visual search since customers switch to word-based search from color-based search (Huang et al., 2021). The effects between color and taste are bidirectional (Spence,

2019). Therefore, colors on labels and packages play a role in influencing taste perception and consumer willingness (Barnett and Spence, 2016).

Much literature has focused on the colors and their perceived tastes. O'Mahony (1983) asked 51 participants to select one of 12 colors for one of the four tastes. The patterns indicated red for sweet, white for salty, yellow for sour, and black and green for bitter when using the color with the highest participant count to represent a flavor. Ares and Deliza (2010) indicated that red and yellow food packaging can create a perception of high sweetness in people.

Heller (1999) reported that the colors and tastes matched by nearly 2000 Germans from various professions. The associations were green and yellow with sour flavor; pink, orange, and red with sweet flavor; white, grey, and blue for salty flavor; and violet, black, and brown for bitter flavor.

Koch and Koch (2003) studied the relationship between colors and the expected flavors of soft drinks, taking 45 university students as a sample. Their findings showed that red and orange caused a sweet flavor; green and yellow caused a sour flavor; yellow and orange caused a citrusy flavor; red, yellow, and orange caused a fruity taste; white caused a salty; and brown caused a syrup taste. The effect sizes of the associations were all at least medium. Furthermore, a single color might cause multiple flavors, such as red and yellow.

Tomasik-Krótki and Strojny (2008) investigated the relations of the seven colors of the rainbow to the five primary flavors (sweet, salty, sour, bitter, and umami). Their study collected more than 500 respondents from 17 countries via questionnaires. They reported the following color-taste relations: red and orange with sweet, yellow and green with sour, blue with salty, and violet with bitter and umami.

Wan et al. (2014) examined cross-cultural, cross-modal correspondences between the visual features and the above five primary flavors. Color is one of the visual features. A total of 452 participants from four countries matched colors to tastes in the survey. They reported the following color-taste patterns across the four countries: black with bitter, green with sour, pink with sweet, and white with salty. Furthermore, their study reported that the country factor significantly interacted with the color-taste patterns.

Lick et al. (2017) reported that the label colors of red wine strongly influence the flavor's expectations, based on 161 red wine buyers in the two stores of an Australian supermarket chain. Their study adapted six colored labels and eight flavors. Each subject rated the match of each color label to each flavor on a scale between 1 to 10. They reported that a color possibly induces multiple flavors: red with tangy, fruity, and flowery; orange with fruity, flowery, and sweet; black for tangy, dry, woody, and earthy; and finally, white with milky flavor. In addition, the frequency of buying wines boosts the association.

Raevskiy et al. (2022) reported a cross-cultural, cross-modal study. Three hundred thirty-eight university students from three countries participated in the online tests. For matching colors to tastes, a participant selected a color from a panel that consisted of 30 colors and five gray colors and then matched it respectively to one flavor in the five basic tastes and in the five oral chem-esthetic sensations (hot, spicy, sharp, fatty, and astringent). Their study has identified partially consistent

patterns across three countries for the color and the primary taste associations. For the patterns in basic tastes, pink and yellow spectrums are sweet; white and blue spectrums are salty; and yellow, green, and orange spectrums are sour. There are no consistent patterns for the bitter and umami tastes across the three countries. The observed patterns for the oral chem-esthetic sensations only include red spectrums with hot and yellow spectrum with fatty.

Table 1 compares the literature on colors and their expected tastes by extending the comparisons from Spence et al. (2015). This study additionally includes the taste context for the comparisons since the taste context determines the available tastes. In the table, the colors investigated in the literature are positioned in the CIELAB color space to reveal their distances. The color space is divided into 14 non-overlapped color sections. The first twelve sections equally divide the a^* b^* color plane, and the last two sections cover black and white colors in the L^* axis in the CIELAB color space. Each color's values of L^*, a^*, b^*, hue angle, chroma, and color section number are provided in the table. Colors are sorted in ascending order according to the hue angle and the color section values.

The table shows consensus in some color sections. Color sections 1 to 3 mainly link to sweet flavor. Color sections 5 to 9 and 11 connect to bitter, sour, and salty tastes. Finally, while the black ties to the bitter flavor, the white links to the salty flavor.

In summary, colors influence consumer expectations and perceived tastes. The taste context determines the available tastes and might affect the perceived tastes for colors. The literature achieves some flavor consensus on only some color sections. In addition, most of the literature focuses on color-taste associations in a general context. This study contributes to the literature by exploring the color-taste associations in the specific context of the tea beverage industry.

Table 1. Summary of results for the cross-modal correspondences between colors and tastes in the literature.

					Study		**O'Mahony (1983)**	**Heller (1999)**	**Koch and Koch (2003)**	**Tomasik-Krótki and Strojny (2008)**	**Wan et al. (2014)**	**Lick et al. (2017)**	**Raevskiy et al. (2022)**	**This study**
							Responses							
					Number of responses		**51**	**2000**	**45**	**519**	**452**	**161**	**348**	**521**
					Area		**USA (CA)**	**Germany**	**USA (OR)**	**17 countries**	**4 countries**	**Austria**	**3 countries**	**Taiwan**
					Type		**University students**	**Cross-section of the public**	**Students**	**High school and university students**	**Internet recruits**	**Buyers in supermarket**	**University students participated online**	**Internet recruits**
CIELAB color space axes					**Taste context**		**General**	**General**	**Soft drink**	**General**	**General**	**Red wine**	**General**	**Tea beverage**
L*	***a****	***b****	**Hue angle**	**Color section**	**Chroma**	**Colors**	**Tastes**							
83.59	24.14	3.32	7.83	1	24.37	Pink		Sweet			Sweet			Sweet
81.05	27.96	5.03	10.19	1	28.41	Light pink							Sweet	Sweet
66.16	42.81	19.55	24.55	1	47.06	Light coral							Sweet	Sweet
37.53	49.69	30.54	31.58	2	58.32	Brown		Bitter	Syrup					Sweet
39.12	55.92	37.65	33.95	2	67.41	Firebrick							Bitter (JP/RU/TW)/Umami (RU)	Sweet
53.24	80.09	67.20	40.00	2	104.55	Red	Sweet	Sweet	Sweet/Fruity	Sweet		Tangy/Fruity/Flowery		Sweet
74.71	31.48	34.54	47.66	2	46.73	Light salmon							Sweet (JP/RU)/Umami (RU/TW)	Sweet
89.35	8.08	21.02	68.96	3	22.52	Peach puff							Umami (JP/TW)	Bitter and astringent
74.94	23.93	78.95	73.14	3	82.50	Orange		Sweet	Sweet/Citrusy /Fruity	Sweet		Fruity/Flowery/ Sweet	Sour (TW)/Umami (JP)	Bitter and astringent
93.73	1.84	11.52	80.94	3	11.66	Moccasin							Sour (JP/RU)	Bitter and astringent

Table 1. (*Continued*).

					Study		O'Mahony (1983)	Heller (1999)	Koch and Koch (2003)	Tomasik-Krótki and Strojny (2008)	Wan et al. (2014)	Lick et al. (2017)	Raevskiy et al. (2022)	This study
							Responses							
					Number of responses		51	2000	45	519	452	161	348	521
					Area		USA (CA)	Germany	USA (OR)	17 countries	4 countries	Austria	3 countries	Taiwan
					Type		University students	Cross-section of the public	Students	High school and university students	Internet recruits	Buyers in supermarket	University students participated online	Internet recruits
CIELAB color space axes					Taste context		General	General	Soft drink	General	General	Red wine	General	Tea beverage
*L**	*a**	*b**	Hue angle	Color section	Chroma	Colors	Tastes							
86.93	−1.93	87.13	91.27	4	87.15	Gold							Sweet (TW)/Sour (JP/RU/TW)	Fresh
97.14	−21.56	94.48	102.85	4	96.91	Yellow	Sour	Sour	Sour/Citrusy/ Fruity	Sour				Fresh
99.64	−2.55	7.15	109.63	4	7.60	Ivory							Salty (JP/RU/TW)/Umami (RU/TW)	Fresh
76.54	−37.99	66.58	119.71	4	76.66	Yellow green							Sour (TW)/Bitter (TW)	Fresh
42.23	−18.83	30.60	121.61	5	35.93	Dark olive green							Bitter (JP/RU/TW)	Fresh
91.96	−52.48	81.86	122.66	5	97.24	Green yellow							Sour (JP/TW)	Fresh
87.74	−86.18	83.18	136.02	5	119.78	Green	Bitter	Sour	Sour	Sour/Bitter	Sour			Fresh
72.09	−23.82	18.03	142.87	5	29.88	Dark sea green							Bitter (JP)	Fresh
				6										Bitter and astringent

Table 1. (*Continued*).

							Study	**O'Mahony (1983)**	**Heller (1999)**	**Koch and Koch (2003)**	**Tomasik-Krótki and Strojny (2008)**	**Wan et al. (2014)**	**Lick et al. (2017)**	**Raevskiy et al. (2022)**	**This study**
								Responses							
							Number of responses	**51**	**2000**	**45**	**519**	**452**	**161**	**348**	**521**
							Area	**USA (CA)**	**Germany**	**USA (OR)**	**17 countries**	**4 countries**	**Austria**	**3 countries**	**Taiwan**
							Type	**University students**	**Cross-section of the public**	**Students**	**High school and university students**	**Internet recruits**	**Buyers in supermarket**	**University students participated online**	**Internet recruits**
CIELAB color space axes							**Taste context**	**General**	**General**	**Soft drink**	**General**	**General**	**Red wine**	**General**	**Tea beverage**
L*	***a****	***b****	**Hue angle**	**Color section**	**Chroma**	**Colors**	**Tastes**								
61.15	−19.68	−7.43	200.68	7	21.03	Cadet blue								Salty (JP/RU/TW)	Bitter and astringent
				8											Bitter and astringent
52.47	−4.07	−32.20	262.79	9	32.45	Steel blue								Salty (JP/RU/TW)	Bitter and astringent
30.83	26.05	−42.09	301.76	11	49.50	Dark slate blue								Bitter (RU)	Bitter and astringent
32.30	79.19	−107.87	306.29	11	133.81	Blue		Salty		Salty					Bitter and astringent
69.70	56.36	−36.82	326.84	11	67.32	Violet		Bitter		Bitter/Umami					Bitter and astringent
53.59	0.00	0.00	0.00	-	0.00	Gray		Salty							-
0.00	0.00	0.00	0.00	L* < 25	0.00	Black	Bitter	Bitter	Bitter		Bitter	Tangy/Dry/Woody/Earthy		Bitter (RU)	Bitter and astringent
100.00	0.00	0.00	0.00	L* > 80	0.00	White	Salty	Salty	Salty		Salty	Milky			Fresh

3. Research design

3.1. Brand logo collecting and reproducing

This study collected the logos on signage, business cards, and menus of 70 tea stores in Kaohsiung City. According to Wang (2020), the city has the most significant number of brands and tea stores in Taiwan. After excluding logos inconsistent on signage, cards, and menus, we employ 69 logos.

The collected logos were then reproduced into 1:1 aspect ratio JPEG images using Adobe Photoshop software. The logo images served as the response options in the questionnaire. **Table 2** shows the 69 brand images and the color sections they were assigned to in the CIELAB color space. This study used the logo's principal color to determine its CIELAB color section. Krzywinski (2023) used the Image Color Summarizer to obtain the logo's principal colors, the color with the highest proportion of area in the logo (Abril et al., 2009).

Table 2. The classification of the 69 logo images into the 12 + 2 color sections in the CIELAB color space according to their principal colors.

Thirty-seven logos in the *a*b plane of the CIELAB color space.**			
Color section	**Hue angle range**	**Cout**	**Logos**
1	10–39	8	
2	30–59	10	
3	60–89	2	
4	90–119	2	
5	120–149	4	
6	150–179	3	
7	180–209	1	

Table 2. (*Continued*).

Thirty-seven logos in the *a*b plane of the CIELAB color space.**			
Color section	**Hue angle range**	**Cout**	**Logos**
8	210–239	1	
9	240–269	1	
10	270–299	3	
11	300–329	2	
12	330–359	0	
	Total	37	
13	$L^* < 25$	6	
14	$L^* > 80$	26	
	Total	32	

This study divided CIELAB color space into 14 non-overlapped color sections, according to MacEvoy (2003). While sections one to twelve equally divide the a^*b^* color plane, sections thirteen and fourteen cover dark ($L^* < 20$) and white ($L^* > 80$) sections in the L^* axis. Having the best performance when compressing JPEG images, the study selects the CIELAB color space to analyze colors.

3.2. Representative logos for each color section

Including 69 logos in the questionnaire would make it lengthy and tedious. The study selected representative logos for each color section in the following ways.

Firstly, a relatively well-known logo is chosen to represent each color section. The analysis assumes that the brand logo having a higher number of stores has relatively higher brand awareness since customers have more opportunities to experience the brands and their logos (Macdonald and Sharp, 2000). Secondly, if a color section holds more than one logo, the study selected an extra relatively well-known logo for every ten logos. This brings the study closer to the brand exposure the consumers experience on the road. For example, two extra logos are selected as representatives in the color section 14 ($L^* > 80$) because the section contains more than 20 logos. **Table 3** lists all 16 representative logos for all color sections.

Table 3. The representative logos for each color section in the questionnaire.

Color section	**1**	**2**		**3**	**4**	**5**
Logo ID	01_0	02_30.1	03_30.2	04_60	05_90	09_120
Logo						
Color section	6	7	8	9	10	11
Logo ID	10_150	11_180	12_210	13_240	14_270	15_300
Logo						
Color section	12	13	14			
Logo ID	-	16_D	06_W1	07_W2	08_W3	
Logo	-					

3.3. Questionnaire

Subjects were asked to select logos they perceived for each taste: sweet, fresh, bitter, and astringent. The study adopted the four tea tastes because they are the common tastes of the tea liquid (Tong et al., 2006). Although other delicate tastes exist (Lai, 2001), only trained experts can identify them.

For each question on a taste, a subject could select up to three logos. The 16 representative logos were randomly presented as options to avoid the answer order bias in the multiple-choice questions.

This study does not use the Likert scale to measure the association between logos and tastes because it would result in a lengthy questionnaire (56 questions), making it challenging to conduct the survey.

3.4. Data collection

The study used an online questionnaire to collect data. Hand-shaken beverages have been developed in Taiwan for more than 30 years. Almost everyone, young and old, has had a drink. Consumers aged 25 to 44 are the primary buyers (Oh, 2016). Since most young people in Taiwan are active on popular social platforms, the young people on social platforms have become an accessible population to reach.

After the pre-test online questionnaires were distributed to the Facebook clubs,

we collected 28 responses. The formal survey distributed 666 questionnaires online to Taiwan's popular social platforms, including Line, Facebook clubs, Dcard social networking service, and PTT. After deleting the responses with color blindness and invalid responses, 521 effective responses were collected, with an effective rate of 78%.

This study collected 521 valid responses, far beyond the required sample size of 323 people. In 2023, young adults aged 15–64 accounted for nearly 70% of Taiwan's total population (Executive-Yuan, 2024) and are the main beverage consumer group. The required sample size is 323 people at a 95% confidence level (z = 1.96), a population proportion of p = 0.70, and a margin of error of E = 0.05, according to the following sample size calculation formula (Taherdoost, 2017): $n = p(1-p)z^2/E^2$.

4. Data analysis

4.1. Demographic statistics

In the 521 responses, males account for 28% of the total gender, while females account for 72%, making up the majority. The proportion of age in descending order is 20–29 years old (59.3%), 30–39 years old (11.3%), under 20 years old (10.9%), 40–49 years old (10.6%), 50–59 years old (7.3%), and over 60 years old (0.6%). Subjects aged 20 to 49 account for 81.1% of the total, which conforms to Taiwan's primary buyers of handshake beverages (Oh, 2016). Nearly 90% of people purchase handshake beverages at least once a week. Milk tea (42%) is the most consumed type of tea, followed by oolong tea (21.1%), black tea (20.2%), green tea (15.5%), and with less than 2% of participants choosing dark tea.

4.2. Independence test for the logo and perceived tastes

Table 4 shows the contingency table for the logos and their perceived tastes, where rows are the logos and columns are the perceived tastes. The study employed the gmodel R package (Warnes et al., 2022) to calculate the Person Chi-square and Cramer's V statistics for the contingency table. The null hypothesis is rejected since the test is significant (Person Chi-square = 4004.5, df = 45, $p < 0.001$). The correlation is strong since Cramer's V = 0.523 exceeds the 0.5 threshold (Howell, 2002; Rea and Parker, 1992).

Figure 1 shows that the logos from 01_0 to 03_30.2 are associated with the sweet taste. Logos from 05_90 to 09_120 are associated with the fresh taste. Logos from 10_150 to 16_D are associated with bitter and astringent tastes. The following section further explores and visualizes the relationships between the logos and their perceived tastes.

Table 4. Contingency table of logos and perceived tastes.

Logo ID	Tastes				Row total
	Astringency	Bitterness	Freshness	Sweetness	
01_0	42	24	14	268	348
02_30.1	13	1	83	306	403
03_30.2	4	5	87	249	345

Table 4. (*Continued*).

Logo ID	Tastes				Row total
	Astringency	Bitterness	Freshness	Sweetness	
04_60	140	155	33	43	371
05_90	11	4	187	130	332
06_W1	55	20	309	7	391
07_W2	56	40	133	6	235
08_W3	66	37	102	8	213
09_120	36	13	166	33	248
10_150	127	70	67	44	308
11_180	134	184	29	5	352
12_210	115	60	22	18	215
13_240	112	198	50	16	376
14_270	101	168	6	24	299
15_300	69	74	5	39	187
16_D	44	120	7	87	258
Column total	1125	1173	1300	1283	4881

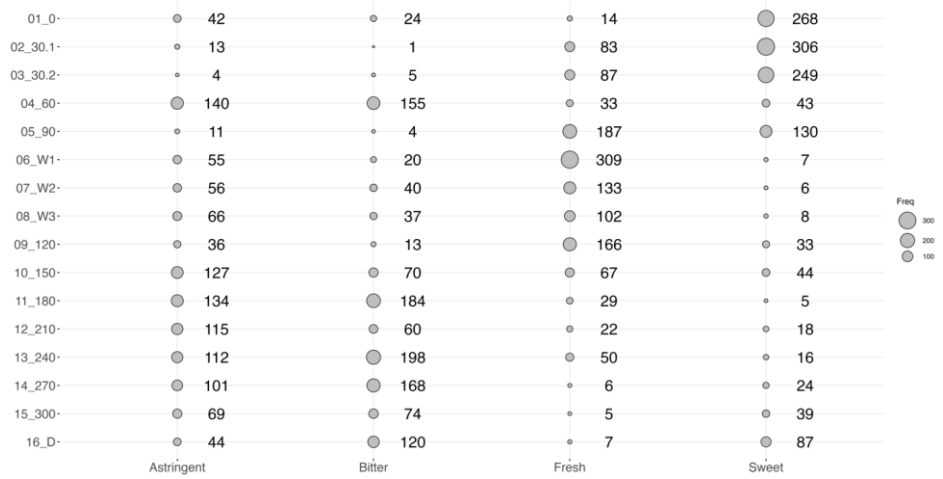

Figure 1. The balloon plot for the contingency table.

4.3. The relationship between logos and perceived tastes

The study further analyzes the relationship between logos and perceived tastes using Simple Correspondence Analysis (Simple CA). The Simple CA can explore the relationship between the two qualitative variables and visualize their relationships in 2D or 3D to help identify the patterns (Nenadic and Greenacre, 2007). The study used FactoMineR (Lê et al., 2008) and factoextra (Kassambara and Mundt, 2020) R packages to perform the Simple CA and data visualization.

The analysis procedure consists of the following steps: First, determine the space's dimensions required for visually representing data points in the contingency table. Second, create a logo space to position the data points of logos in the space. Third, we create a perceived taste space to plot the data points of tastes in the space. Finally, the logo and perceived taste spaces are combined to visualize their relative

positions and thus identify their relationships. The details are presented in the following sections.

4.3.1. Dimensions required for visual representation

According to Bendixen (1995), one should consider a dimension if its explained variation exceeds the threshold of 33.3% (max [1/(16-1), 1/(4/1)]) for a contingency table with 16 rows and four columns. **Table 5** shows the percentage of variance explanations for three dimensions after executing the Simple CA analysis. Only the first and second dimensions exceed the threshold, explaining 57.375% and 38.793% variance, respectively. Therefore, a two-dimensional space is sufficient for the visual representation.

Table 5. Eigenvalues and the percent of variance for three dimensions.

Dimension	Eigenvalue	Percent of variance	Cumulative of variance percent
Dim.1	0.471	57.375	57.375
Dim.2	0.318	38.793	96.168
Dim.3	0.031	3.832	100.000

4.3.2. Visualizing data points of logos

Before interpreting visually, one should first examine the visualization quality. The Cos2 indicator in the CA analysis can measure the quality of the spatial representation of the points in the space. The quality is better if the sum of Cos2 values across all dimensions is closer to 1 (Kassambara, 2017).

The sum of Cos2 under two dimensions for each logo is shown in **Table 6**. The average value of the Cos2 of all the brand logo colors is 0.919. All the logos have satisfactory visual representation qualities except for the logo 10_150 (Cos2 = 0.507).

Table 6. Cos2 values for brand logo colors (rows in the contingency table).

Logo ID	Dim. 1	Dim. 2	Total
01_0	0.537	0.452	0.990
02_30.1	0.839	0.161	1.000
03_30.2	0.891	0.107	0.998
04_60	0.867	0.125	0.991
05_90	0.704	0.279	0.984
06_W1	0.034	0.964	0.997
07_W2	0.016	0.984	1.000
08_W3	0.086	0.863	0.949
09_120	0.112	0.887	1.000
10_150	0.499	0.008	0.507
11_180	0.949	0.046	0.994
12_210	0.607	0.022	0.629
13_240	0.892	0.030	0.922
14_270	0.801	0.166	0.967
15_300	0.566	0.412	0.978
16_D	0.107	0.687	0.794

The factor map in the CA analysis visualizes the relative positions among data points in a space. The columns (rows) in the contingency table are drawn as points in the space. The angle between the two points relative to the spatial origin represents the degree of correlation—the smaller the angle, the higher the relationship (Kassambara, 2017).

Figure 2 shows the factor map for the logos. The logos are divided into three groups. Group 1 includes the brand logos of the IDs 01_0, 02_30.1, and 03_30.2, located in the upper left corner of the space. These logos are in color sections 1 and 2 (Hue angle from 0 to 59 degrees). The study names this group the Warm Scheme.

Group 2 includes logos of the IDs 10_150, 11_180, 12_210, 13_240, 14_270, 15_300, 16_D, and 04_60, located in the upper right corner of the space. These logos are in the color section 3 (hue angle from 60 to 89 degrees), sections 6 to 11 (hue angle from 150 to 329 degrees), and section 13 ($L^* < 25$). The study names this group as the Cold Black Scheme.

Group 3 includes the logos of the IDs 05_90, 06_W1, 07_W2, 08_W3, and 09_120, located in the lower part of the space. These logos are in the color section 4 (hue angle from 90 to 119 degrees), section 5 (hue angle from 120 to 149 degrees), and section 14 ($L^* > 80$). The study names this group as the Cool White Scheme.

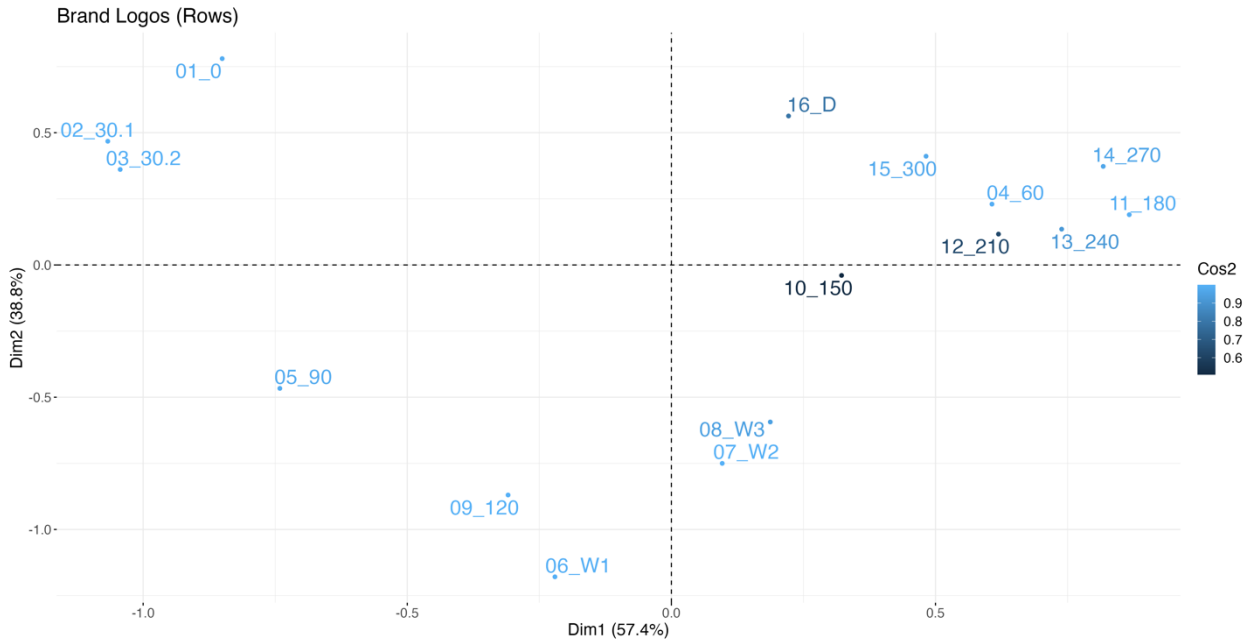

Figure 2. The factor map for the Logos (rows) in the contingency table.

4.3.3. Visualizing data points of the perceived tastes

The representation quality of the perceived taste in two-dimensional space is examined. All the Cos2 values of the perceived tastes are above 0.80, which indicates a good quality of the spatial representation, as shown in **Table 7**.

The perceived tastes are divided into three groups, as shown in the factor map of **Figure 3**. Group 1 is sweetness, located in the upper left corner of the space. Group 2 is bitterness and astringency, located in the upper right corner. Group 3 is freshness, located in the lower left of the space.

Table 7. Cos2 values for perceived taste (columns in the contingency table).

Perceived Taste	Dim.1	Dim.2	Total
Bitterness	0.819	0.115	0.934
Freshness	0.120	0.877	0.997
Sweetness	0.705	0.295	1.000
Astringency	0.805	0.005	0.810

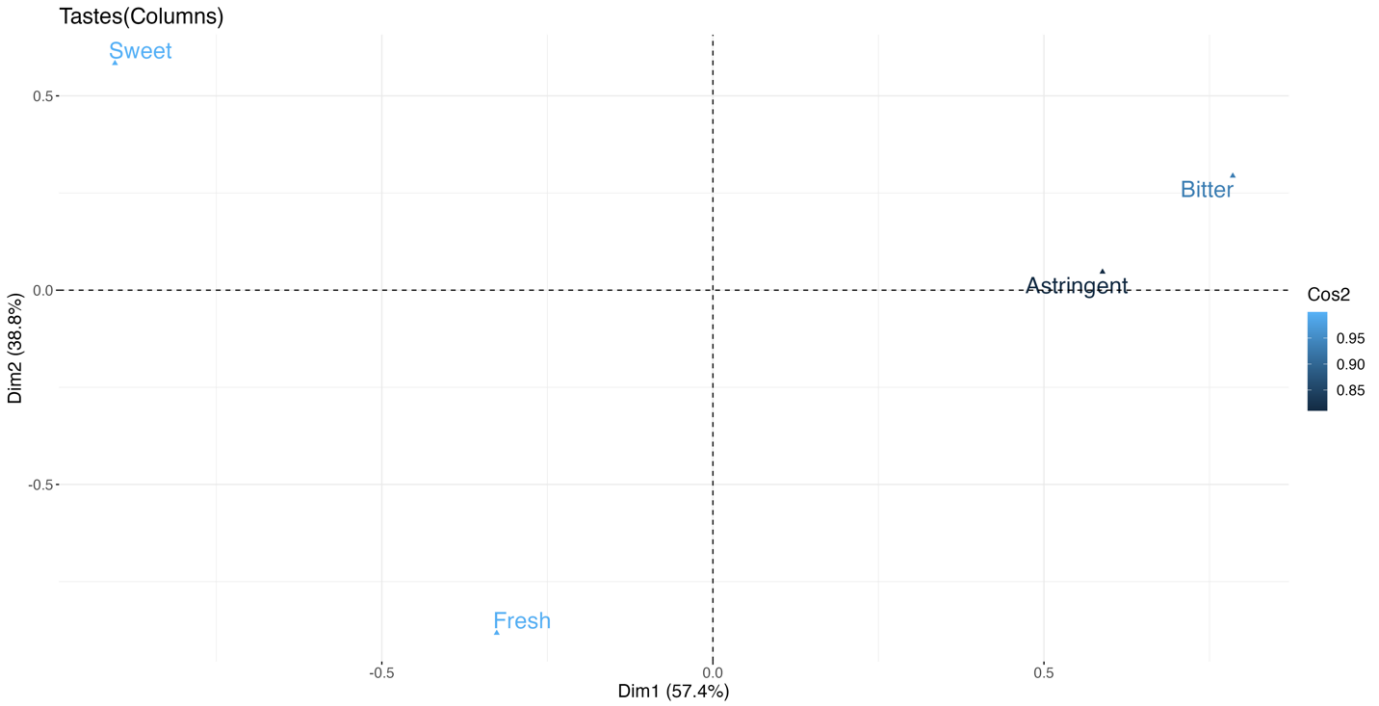

Figure 3. The factor map for the perceived tastes (columns) in the contingency table.

4.3.4. Visualizing the relationship between logos and perceived tastes

The study uses the asymmetric biplot to visualize the data points of logos and tastes in the same space to reveal their relationship. The asymmetric biplot can plot data points in the column space of the contingency table onto the row space to understand the relationship between the data points in the two spaces. In the asymmetric biplot, the angle between the two points relative to the spatial origin represents the degree of correlation. The closer the angle between the two points, the higher their correlation (Kassambara, 2017).

The asymmetric biplot for the logos and perceived tastes is shown in **Figure 4**. The logos and perceived tastes are clustered into three groups. The first data cluster appears in the upper left corner of the space, in which the Warm Scheme logos are associated with the sweet taste. The second data cluster appears in the upper right corner of the space, in which the Cold Black Scheme logos are associated with bitter and astringent tastes. Finally, the third data cluster appears in the lower left corner of the space, in which Cool White Scheme logos are associated with the fresh taste.

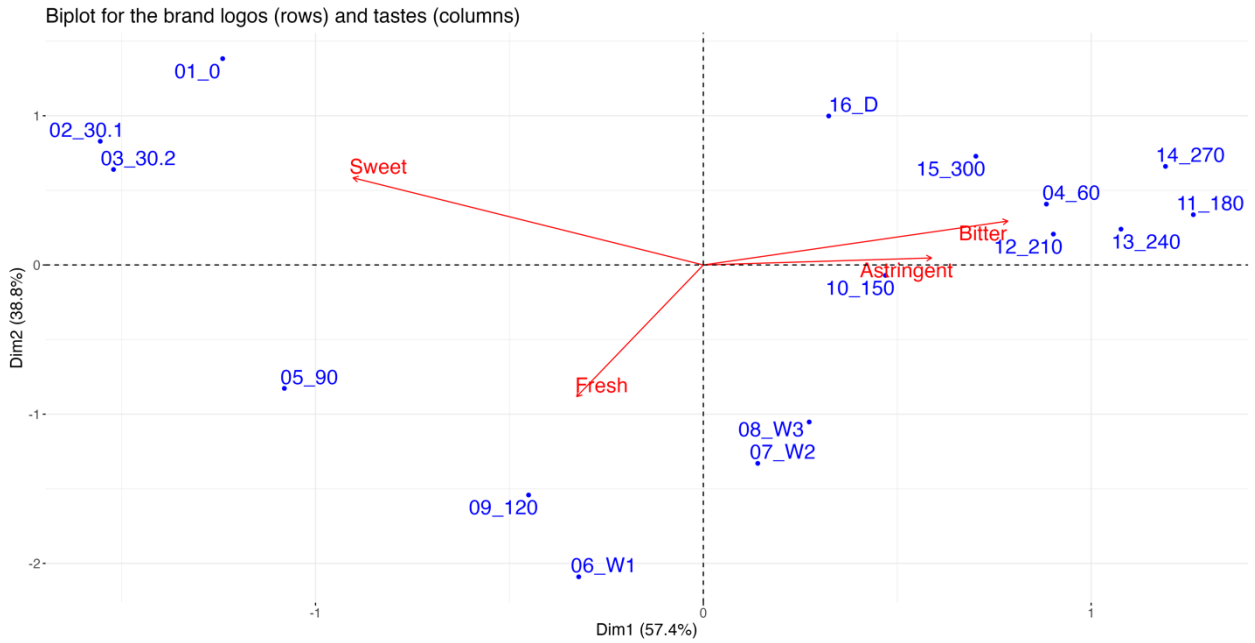

Figure 4. The asymmetric biplot for the logos and perceived tastes (rows and columns in the contingency table).

5. Discussion

The colors on the logos cause various taste sensations, as indicated by the results of the analysis. The logos can be clustered into three taste perception groups:

1) The Warm Scheme logos are associated with sweetness, as shown in **Figure 5**. The Warm Scheme logos are those in the color sections 1 and 2 (Hue angle from 0 to 59 degrees). Secondly, the Cold Black Scheme logos are associated with bitterness and astringency.

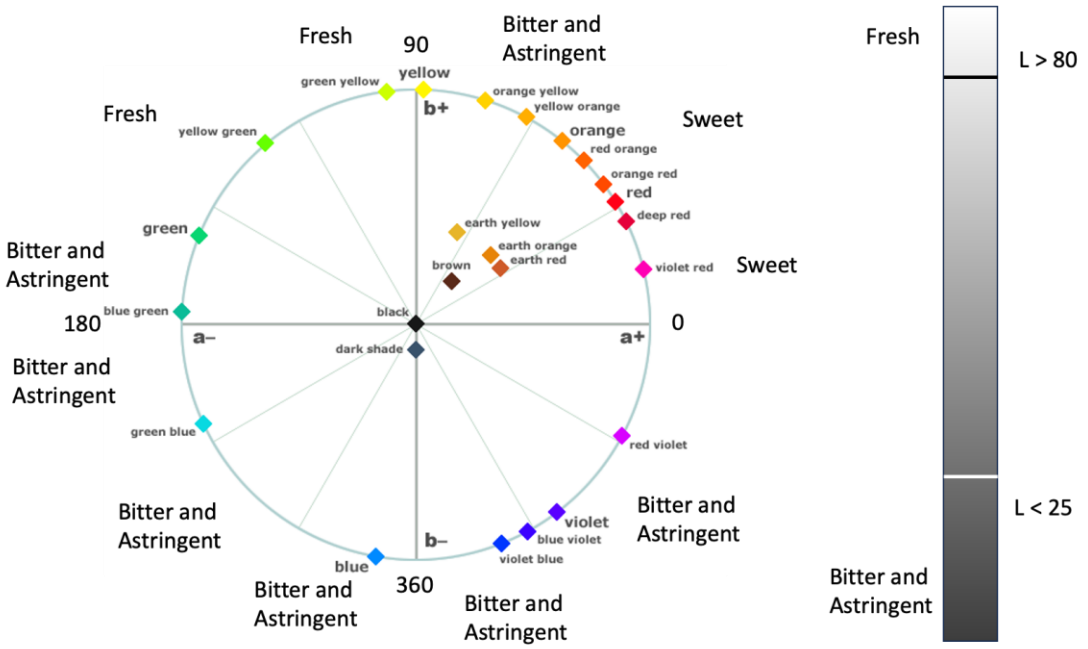

Figure 5. The association of color sections with perceived tastes for tea beverages using CIELAB color space.
The figure is created based on the CIELAB hue circle from MacEvoy (2003).

2) The Cold Black Scheme logos are those in the color section 3 (hue angle from 60 to 89 degrees), sections 6 to 11 (hue angle from 150 to 329 degrees), and section 13 ($L^* < 25$). Finally, the Cool White Scheme logos are associated with freshness.
3) The Cool White Scheme logos are those in the color section 4 (hue angle from 90 to 119 degrees), section 5 (hue angle from 120 to 149 degrees), and section 14 ($L^* > 80$). We discuss them further below.

5.1. The warm scheme logos and sweet perception

The brand logos with sweet taste use the colors in the Warm Scheme, which contains the color sections 1 and 2 (Hue angle from 0 to 59 degrees), as shown in **Table 8**. Colors such as red and pink belong to the Warm Scheme. This result is similar to the research results of Wan et al. (2014), Raevskiy et al. (2022), O'Mahony (1983), Heller (1999), Lick et al. (2017), and Koch and Koch (2003). However, there are two exceptions in the Warm Scheme. Brown and fire brick are reported to cause bitterness in Heller (1999) and Raevskiy et al. (2022), respectively. The exceptions might be caused by the inconsistency in the taste context. The taste context for the two studies is general food, but this study focuses on tea beverages.

Table 8. The Warm Scheme logos induce the perceived sweet taste for tea beverages.

Color section	**1**	**2**	
Hue Angle Range	0–29	30–59	
Logos and IDs	 01_0	 02_30.1	 03_30.2

5.2. The cold black scheme logos and bitter and astringent perceptions

The logos with bitterness are primarily in the Cold Black Scheme, as shown in **Table 9**. The Cold Black Scheme contains the color section 3 (hue angle from 60 to 89 degrees), sections 6 to 11 (hue angle from 150 to 329 degrees), and section 13 ($L^* < 25$).

Table 9. The Cold Black Scheme logos induce the perceived bitter and astringent tastes for tea beverages.

Color section	**3**	**6**	**7**	**8**	**9**	**10**	**11**	**13**
Hue Angle Range or L^* value	60–89	150–179	180–209	210–239	240–269	270–299	300–329	$L^* < 25$
Logo and ID	 04-60	 10-150	 11-180	 12-210	 13-240	 14-270	 15-300	 16-D

The logos in color section 13 ($L^* < 25$) have a dark color, such as black. The result of the bitter perception of the dark color aligns with the studies of O'Mahony (1983), Heller (1999), Koch and Koch (2003), Wan et al. (2014) and Raevskiy et al. (2022). Individual experiences and memories shape color associations. Dark colors

are easily associated with dark or black foods, such as coffee or dark chocolate, which usually taste bitter (Smets and Overbeeke, 1995).

Other Cold Black Scheme logos are in sections 6 to 11 (hue angle from 150 to 329 degrees). These logo's principal colors approximate dark green, blue, and violet. Due to the dark color, the logos with the dark green might induce bitterness and astringency. Violet is reported to be associated with a bitter taste (Heller, 1999; Tomasik-Krótki and Strojny, 2008). However, the taste perception of the blue color for the tea beverage differs from the results of other studies. Blue is reported to be associated with a salty taste (Heller, 1999; Raevskiy et al., 2022; Tomasik-Krótki and Strojny, 2008). Since tea beverages hardly have a salty taste, customers might have little probability of associating a color with a salty taste in the context of tea beverages. That might explain the inconsistency. As for the astringency, works of literature in general food and soft drink contexts have not reported colors associated with it.

The last color section of the Cold Black Scheme, section 3, contains the logo with an orange-yellow color with low chroma. Recall that the Cold Black Scheme logos are associated with bitterness and astringency. The orange color is reportedly sweet (Lick et al., 2017; Raevskiy et al., 2022; Tomasik-Krótki and Strojny, 2008). The chroma of the color might contribute to the inconsistency with the literature. The orange-yellow color with low chroma might remind customers of the tastes of burnt food or dark traditional Chinese medicine, which usually tastes bitter or astringent. When increasing the chroma of the colors in section 13, the taste sensation might change to sweetness or freshness, which are adjacencies to the color section 3 in CIELAB space.

5.3. The cool white scheme logos and fresh perception

The logos with fresh taste perception are mainly in the Cool White Scheme, including color sections 4 and 5 (hue angle from 90 to 149 degrees) and section 14 ($L^* > 80$). The principal colors of the logos include yellow, green-yellow, yellow-green, and white, as shown in **Table 10**.

Table 10. The cool white scheme logos induce a fresh taste sensation for tea beverages.

Color section	**4**	**5**	**14**		
Hue Angle Range or L^* value	90–119	120–149	$L^* > 80$		
Brand Logos and IDs					
	05-90	09-120	06-W1	07-W2	08-W3

Yellow and green and their mix might induce a fresh perception. First, the yellow, yellow-green, and green-yellow colors are commonly associated with a sour taste (Heller, 1999; Koch and Koch, 2003; O'Mahony, 1983; Raevskiy et al., 2022; Tomasik-Krótki and Strojny, 2008). For gustatory, sourness can increase the appetite and refresh the taste. Next, the mixed yellow and green colors bring out a mix of sour and sweet taste sensations. Sweetness is one of the positive drivers of freshness

(Heenan et al., 2008). Then, for visual, green is usually associated with nature, health, growth, and prosperity. Hence, combining the multiple sensations might induce a fresh taste sensation for tea beverages (Fenko et al., 2009).

As for the white color in the Cool White Scheme, although many previous studies have pointed out that white produces a salty taste (Harrar and Spence, 2013; Koch and Koch, 2003; Wan et al., 2014), customers might not associate white with saltiness, as tea beverages have no salty taste. Consumers rely on words on the packaging to visually search for the product if the color cannot generate taste expectations in their life experiences (Huang et al., 2021). The words on the logos might cause a fresh perception. For example, the Chinese name of the 06-W1 logo is Xian Cha Dao (鮮茶道), in which Xian (鮮) means freshness, which might give customers a fresh taste sensation. Another possibility is that white is a pure and quiet color that offers a fresh visual sensation and might remind customers of the fresh tea taste.

6. Conclusion

This empirical study explores the perceived tastes of tea beverages caused by the logo's principal colors, taking hand-shaken beverage logos in Taiwan as an example. First, the collected logos are allocated into the color sections in the CIELAB space according to their primary colors. The CIELAB color space is divided into 14 color sections that contain 12 equally divided sections in the a^*b^* plane segmented by hue angles and the two sections in the L^* axis ($L^* < 25$ and $L^* > 80$). Next, this study uses the correspondence analysis method to cluster logos and perceived tastes to identify their associations visually. Then, the tea tastes are mapped to the CIELAB color space through the associations between the logo and the perceived tastes.

According to our analytical results, the sweet perception links to the logos with Warm Scheme colors, including the color sections 1 and 2 (hue angle from 0 to 59 degrees), such as red and orange. Then, the bitter and astringent perceptions link to the logos with Cold Black Scheme colors, including the color sections 3 (hue angle from 60 to 89 degrees, e.g., green and blue), sections 6 to 11 (hue angle from 150 to 329 degrees, e.g., green-yellow and yellow-green), and section 13 ($L^* < 25$, e.g., black). Finally, the fresh perception links to the logos with the Cool White Scheme colors, including the color sections 4 and 5 (hue angle from 90 to 149 degrees, e.g., green-yellow and yellow-green) and the color section 14 ($L^* > 80$, e.g., white).

This study contributes to the literature on color-taste associations by expanding the general food taste context to tea beverages because color-taste relationships in domains are non-transferable (Spence, 2019). Moreover, the range of colors has been extended beyond the primary colors (e.g., red, blue, and yellow) to almost the entire CIELAB color space.

The contribution can assist the hand-shaken companies in selecting the principal colors from a broad color space to align the logo and package colors to the perceived tastes of their beverages and accurately convey brand recognition. When selecting white as the principal color, the literal meaning of brand names on the logos might affect the perceived tastes. In that case, because the brand name could lead to

perceived tastes, companies should consider whether the brand names match the products' perceived tastes.

The results of this research can also help other hand-shaken beverage companies in different cultural regions. Taiwan's hand-shaken beverage culture has been exported worldwide and has gradually become a new local beverage culture. Because the color-taste association is not transferable across domains (Spence, 2019) and is affected by culture (Shankar et al., 2010), consumers must relearn the association between the color and taste of tea beverages when facing this new culture. Although the results of this study are based on consumers in Taiwan, beverage companies in other regions can refer to the results of this study while considering local culture to find color choices in packaging suitable for local consumers to convey the taste characteristics of the product accurately. Combining regional experience in Taiwan and cultural differences in overseas markets can help companies better enter international markets and promote regional economic development.

Due to limited resources, this study has several limitations:

1) This study only categorizes the logos based on color hue and does not consider chroma.
2) One of the 14 color sections does not contain logos, although this study has covered almost all color sections in the CIELAB color space.
3) The study explores the taste perception caused by logo color, not the actual taste of the tea beverages.
4) This study focuses primarily on Taiwanese hand-shaken drink brands.

Future research directions include the following suggestions: One can explore how brand names on the logos with white as the primary color affect the perceived taste of tea. Secondly, one can examine whether other variables interfere with the impacts of logo colors on perceived tastes, such as brand awareness. Thirdly, one can explore variables including the light, location, size, and color difference between the log and the background because they are all vital variables that physically affect the taste perception caused by logos. Fourthly, it would gain more insight by comparing the logo design of leading products with other products qualitatively or quantitatively. Fifthly, since text is an essential element in logo design, the influence of text types and contents would be worth studying. Finally, it would be valuable to investigate the perceived tastes of consumers from different regions regarding hand-shaken tea beverages.

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