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Assessment of Sensory Attributes in White Tea Utilizing the High Identity Traits (HITS) Methodology Employing an Immersive Approach

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ABSTRACT

White tea is a plant-derived product from Camellia sinensis L, which is processed without enzymatic oxidation and fermentation. The high identity traits (HITS) is a sensory evaluation method that identifies dominant attributes using five attributes to describe each sample. The sensory evaluation research on white tea uses the HITS method with an environmental approach aimed at identifying dominant attributes of white tea using both trained and untrained panelists, as well as at determining the intensity of these dominant attributes using an environmental approach with both trained and untrained panelists. The materials used were five samples of Gamboeng white tea, Heizl, Dandang, Pucuk, and Ennie1. The HITS method with trained panelists successfully identified dominant attributes as follows: yellow-brown brew color, rose aroma, rose flavor, astringent aftertaste, and light mouthfeel. Meanwhile, the experiment using untrained panelists showed dominant attributes as follows: yellow-brown brew color, jasmine aroma, jasmine flavor, astringent aftertaste, and light mouthfeel. The HITS method with an immersive approach for both trained and untrained panelists had an impact on increasing the intensity of aroma, flavor, and mouthfeel while decreasing the intensity of aftertaste.

Keywords: *high identity traits (HITS), immersive, trained panelists, untrained panelists, white tea*

INTRODUCTION

Tea is one of the most widely consumed beverages after water in the world, with approximately 290 billion liters sold in retail and food service (Chueamchaitrakun *et al.,* 2018). The largest tea-producing countries are China, Japan, Taiwan, Indonesia, Thailand, Sri Lanka, Vietnam, Turkey, Kenya, and Russia (Fadhilah *et al.,* 2021). In 2020, Indonesia was one of the largest tea-producing countries in the world, producing 138,323 tons from *Camellia sinensis* L. plants (Hadiansyah *et al.*, 2023). Tea originates from the *Camellia sinensis* plant, which is categorized into several groups based on its processing methods, namely non-fermented teas (green tea and white tea) and fermented tea (black tea) (Leslie and Gunawan, 2019).

White tea is a plant-derived from *Camellia sinensis* L, which is one type of tea that undergoes a processing method without enzymatic oxidation, resulting in higher antioxidant content compared to other teas (Hadiansyah *et al.*, 2023). The food industry carries out ongoing developments in white tea products. Sensory profile characteristics are examined to enhance product development. Food products with good taste may not necessarily be successful in consumer acceptance in the market. Environmental influences can affect consumer perception and behavior. Contextual cues that can influence sensory consumer acceptance include visual, auditory, olfactory, tactile, and multisensory aspects (Seo, 2020). Sensory evaluation testing in situations closer to consumers can measure more representative panelist reactions, resulting in more valid data collection. Sensory evaluation testing conducted in laboratories may lead to lower acceptance ratings. Environmental influences play a crucial role in product acceptance. The use of virtual media depicting a specific place, such as a restaurant, cafe, or home, is employed to evaluate acceptance (Picket and Dando, 2019). This method is referred to as the immersive method. The immersive method is used to make someone feel present in an environment. Feeling present in an environment is a crucial factor in determining the level of desire, preference, and product acceptance. The immersive method utilizes props, projections, photos, scenarios, screens, and virtual reality (Colla *et al.,* 2022).

Descriptive sensory analysis is a method used to identify and measure the perceived intensity of

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sensory characteristics in a product. Descriptive analysis is detailed, accurate, reliable, and consistent (Adawiyah *et al.,* 2019). This method employs complex sensory terms, or attributes, to describe food characteristics. When conveying information with complex terms to non-technical individuals, sensory attributes may need to be accurately communicated for the product's essential identity. This approach uses trained panelists to develop a comprehensive sensory profile of the product. Training trained panelists is time-consuming and expensive, posing challenges for industries facing resource, cost, and time constraints. Several alternative methods have been developed to provide faster results and can be conducted by a small number of panelists or even without training. Analytical methods with a consumer-oriented approach have emerged, allowing consumer panelists to describe sensory product profiles for market readiness (Belusso *et al.,* 2016).

Methods to identify complex sensory attributes have been developed using more straightforward language, allowing untrained panelists (consumers) to describe the main characteristics of the product with little or no training (Talavera-Bianchi *et al.,* 2010). The high identity traits (HITS) method is one such approach developed to help differentiate products using more straightforward sensory attributes, utilizing a maximum of five attributes to describe each sample (Cicone, 2013). Sensory evaluation research on white tea uses the HITS method with an environmental context approach to identify dominant attributes of white tea using both trained and untrained panelists, as well as identifying the suitable environment for consuming white tea. This study aims to provide dominant sensory profile characteristics of white tea with an environmental approach.

MATERIALS AND METHOD

Materials

The materials used include five white tea brands: Gamboeng from PT Riset Perkebunanan Nusantara, Bandung Regency; Heizl from CV Ganda Mas, Surabaya City; Dandang from PT Kartini Teh Indonesia, Batang Regency; Pucuk from CV Sinar Camellia, Cianjur Regency; and Ennie1 from Bandung City. The samples used have obtained distribution permits from BPOM (Indonesian Food and Drug Authority) or the Health Department and were purchased through online stores. Crackers and mineral water were provided to neutralize the taste and aroma of each test sample.

Panelists

This research has been approved to use human subjects from the Research and Community Service Institute (LPPM) of IPB University, Bogor, Indonesia, with approval number 1019/IT3.KEPMSM-IPB/SK/ 2023. The panelists used in this study include both trained and untrained individuals. According to the Indonesian National Standard (SNI) 01-2346 of 2006 (BSN, 2006), the number of trained panelists should be six individuals. In this study, there were nine trained panelists (women) with an age range of 26–50 years, the panelists were trained based on ISO 8586:2012, which had been conducted in the research Hadiansyah *et al.* (2023) using the same sample of white tea. According to SNI ISO (2012), the number of untrained panelists should be 30 individuals. Untrained panelists (consumers) were selected by choosing individuals who consume non-fermented teas like green or white tea at least once a week. In this study, there were 30 untrained panelists, both female and male, with an age range of 20–45 years. Both trained and untrained panelists were willing to participate in sensory evaluations, were in good health, and did not have any olfactory or gustatory impairments.

Brewing tea

White tea is weighed at 3 g, then infused in 150 mL of hot water at a temperature of 98 °C in a cup for 7 min (Pérez-Burillo *et al*., 2018). After 7 min, the infusion is filtered and stirred ten times. The test sample is presented in a 30 mL plastic cup labeled with three digits at a temperature of 70 °C.

Focus group discussion (FGD)

Focus group discussions (FGD) were conducted to determine the five primary sensory attributes of the five white tea test samples. FGD sessions were held separately for trained and untrained panelists at different times. The sensory attributes of white tea used were infusion color (yellow-brown); aroma (floral jasmine, floral rose); taste (bitter, umami); flavor (floral jasmine, floral rose); aftertaste (astringent); and mouthfeel (light, smooth, thickness) (Hadiansyah *et al.*, 2023). Panelists were provided with five test samples, each labeled with a sample code. After each sample change, panelists had to neutralize their palates by consuming crackers and drinking mineral water.

Sensory evaluation with the high identity traits (HITS) modified method

Both trained and untrained panelists conducted evaluations on the intensity of five sensory attributes for five white tea test samples. The intensity levels used were strong, moderate, weak, and none (Talavera-Bianchi *et al.,* 2010). In this study, a modified HITS method was used on the intensity scale. The 15 cm ratio scale ranged from no intensity to strong intensity. The sensory attributes used were the five attributes derived from the focus group discussions (FGD). Panelists conducted tests alternately, and palate neutralization with mineral water and plain crackers was performed after each sample change.

Sensory evaluation with HITS modified method using an immersive approach

Both trained and untrained panelists conducted evaluations on the intensity of five sensory attributes for five white tea test samples using a 15 cm ratio scale. During the review, panelists utilized virtual reality (VR) tools with the specifications of VR Shinecon G12 Black while watching immersive videos such as Figure 1, allowing them to feel present in natural environment with a riverside view. This environment was selected because of consumers' habits of consuming tea while on the riverside, particularly cool temperatures. The 15 cm ratio scale ranged from no intensity to strong intensity. The sensory attributes used were the five attributes derived from the focus group discussions (FGD). Panelists conducted tests alternately, and palate neutralization with mineral water and plain crackers was performed after each sample change.

Figure 1. The appearance of video on a virtual reality device

Data processing

The data processing results of the sensory evaluation of white tea using the HITS method with an immersive approach were carried out using microsoft excel and XLSTAT 2023 software. Microsoft excel software produced outputs such as spiderweb and histogram charts obtained from the average intensity values of each attribute for the five test samples. XLSTAT 2023 software, with the Principal Component Analysis feature, generated a biplot graph.

RESULT AND DISCUSSION

Dominant attribute white tea

Trained and untrained panelists shown a focus group discussion (FGD) with the aim of identifying five dominant attributes of the test samples. The FGDs were conducted separately. The list of sensory attributes, along with the definitions used for the FGD of white tea, according to Hadiansyah *et al.* (2023) can be seen in Table 1.

The results of the focus group discussion (FGD) conducted with trained and untrained panelists can be seen in Table 2. The FGD results from trained and untrained panelists yield different attributes, namely aroma and flavor, while other attributes show no differences. This variation may be attributed to the panelists' sensitivity level in identifying sensory attributes. Based on the research findings of Cicone (2019), the FGD results will be utilized to evaluate sensory aspects using the high identity traits (HITS) method to determine the intensity of the five attributes across all test samples.

Dominant sensory attributes in white tea utilizing the HITS modified methodology

HITS is one of the methods developed to help differentiate products using more straightforward sensory attributes, utilizing no more than five traits to describe each sample (Cicone, 2019). In this research, sensory variables are used as attributes, and the research object is white tea. The correlation and similarity relationships among variables and objects are depicted in a biplot graph. A biplot graph provides crucial information, such as the proximity of observed objects, serving as a guide to understanding the similarity among objects, the relative position of objects, and the diversity of a variable (Anuraga, 2015).

Table 1. Definitions of sensory attributes of white tea

Category	Sensory Attribute	Definition
Brew Color	Yellow-brown	The brew color has a thin to brownish-yellow color
Aroma	Floral jasmine	Aroma is associated with jasmine flowers
	Floral rose	Aroma is associated with rose flowers or floral notes
Flavor	Floral jasmine	When consumed, it gives a sensation reminiscent of jasmine flowers
	Floral rose	When consumed, it gives a sensation reminiscent of roses or floral notes
Taste	Umami	The basic taste of monosodium glumatame
	Bitter	The basic taste of caffeine
Aftertaste	Astringent	Dry sensation on the tongue and mouth surface
Mouthfeel	Light	Light sensation in the mouth
	Smooth	Smooth sensation in the mouth
	Thickness	Thick sensation in the mouth

Table 2. Result of FGD with trained and untrained panelists

Category	Trained Panel Attributes	Untrained Panel Attributes
Brew Color	Yellow-brown	Yellow-brown
Aroma	Floral rose	Floral jasmine
Flavor	Floral rose	Floral jasmine
Aftertaste	Astringent	Astringent
Mouthfeel	Light	Light

The closer the points of variables and objects, the greater their involvement or the characteristics of the sample are nearly similar (Arina *et al.,* 2022). The correlation relationship between sensory attributes and the five samples of trained panelists is presented in the principal component analysis (PCA) biplot graph shown in Figure 2A. Figure 2A indicates the presence of two main components in the research results, namely F1 (61.59%) and F2 (25.06%), which can explain 86.65% of the diversity of data.

Based on Figure 2A, the sensory profile of trained panelist samples reveals correlations among sensory attributes and samples. These correlations can be observed from the position of the attribute points. Adjacent samples points on the biplot graph had the same sensory attributes and were positively correlated, while samples located in opposite positions had different descriptions and exhibited a negative correlation. Samples Pucuk and Gamboeng share similarities in the sensory attribute of rose flavor because both points are in the same quadrant. On the other hand, samples Dandang, Ennie1, and Heizl have distinct product characteristics as their points are located in different quadrants. The furthest point in Figure 2A is the aftertaste astringent, making it the most significant attribute compared to others. The farther a variable is from the origin or point 0.0, the more significant its contribution to the PCA biplot graph (Umar *et al.,* 2016). At the upper-left of the biplot graph, Ennie1 dominates with the sensory attributes of light, a mouthfeel, and an astringent aftertaste. At the upper-right of the biplot graph, Dandang is present with the sensory attribute charac-teristic of rose aroma. At the lower-right of the biplot graph is dominated by Pucuk and Gamboeng, with the attribute of rose flavor. At the lower-left of the biplot graph, Heizl is present with the sensory attribute characteristic of a yellow-brown color of the brew color.

Based on Figure 3A, there is a high intensity of the brew color yellow-brown in the Heizl sample. High intensity of rose aroma was identified in the Dandang sample. High intensity of rose flavor was identified in the Gamboeng sample. High intensity of astringent aftertaste was identified in the Ennie1 sample. High intensity of light mouthfeel was identified in the Heizl sample.

The correlation relationship between sensory attributes and the five samples of untrained panelists is presented in the principal component analysis (PCA) biplot graph, as shown in Figure 2B. Figure 2B indicates the presence of two primary components of the research results, namely F1 (49.20%) and F2 (42.28%), which can explain 91.48% of the diversity of data. Adjacent samples points on the biplot graph had the same sensory attributes and were positively correlated, while samples located in opposite positions had different descriptions and exhibit a negative correlation. The Dandang and Gamboeng samples exhibited similarity in the sensory attribute of the jasmine flavor as both points are located in the same quadrant.

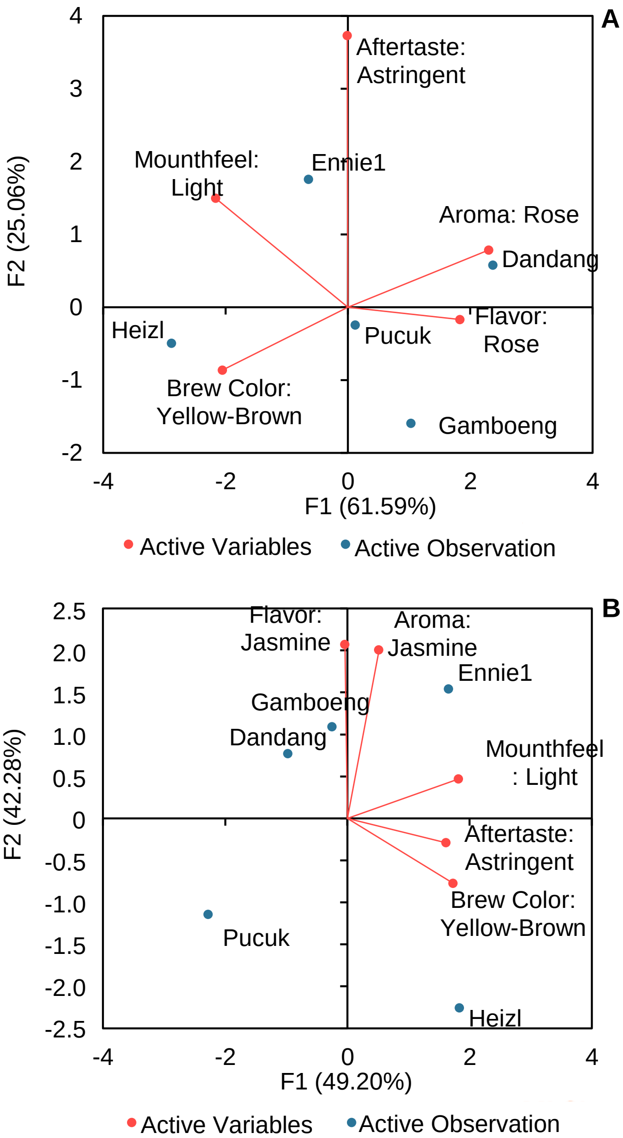

Figure 2. PCA HITS biplot graph of trained panelist (A) untrained panelist (B)

On the other hand, the Ennie1, Heizl, and Pucuk samples have distinct product characteristics as their points are located in different quadrants. The farthest point in Figure 2B represents the jasmine flavor, making it the most significant attribute compared to others. At the upper-left of the biplot graph, the Dandang and Gamboeng samples exhibit characteristics of the jasmine flavor attribute. At the upper-right of the biplot graph, Ennie1 dominates the sensory attributes of jasmine aroma and light mouthfeel. At the lower-right of the biplot graph, Heizl has characteristics of an astringent aftertaste and a brew color of yellow-brown. At the lower-left of the biplot graph, the Pucuk has sensory characteristic of jasmine aroma and light mouthfeel with low density.

The intensity of attributes from untrained panelists in Figure 3B shows high intensity in the yellow-brown brew color for the Heizl sample. High intensity of jasmine aroma was identified in the Ennie1 sample. High intensity in jasmine flavor was identified in the Ennie1 sample. High intensity in the astringent aftertaste was identified in the Heizl sample. High intensity in light mouthfeel was identified in the Ennie1 sample. The evaluation of each sample by trained and untrained panelists in both the PCA biplot graph and spiderweb graph exhibits differences in intensity due to variations in sensitivity levels and the ability to perform identification.

Dominant sensory attributes in white tea utilizing the HITS modified methodology with an immersive approach

High identity traits (HITS) modified using the immersive approach involve sensory evaluation to distinguish products using more straightforward sensory attributes, employing no more than five traits to describe each sample by modifying the surrounding environment. In this study, the environmental modification utilized virtual reality tools based on Figure 4. Previous research has shown that sensory intensity using immersive methods is higher compared to sensory evaluations conducted in a laboratory setting (Sinesio *et al.,* 2017; Stelick *et al.,* 2018; Chen *et al.,* 2020; Torrico *et al.,* 2021). In Figure 5A, there are two primary components of the research results, namely F1 (68.15%) and F2 (24.58%), which can explain 92.73% of the diversity of the data. The farthest point in Figure 5a represents the rose aroma, making it the most significant attribute compared to others.

At the upper-left of the biplot graph of Figure 5A, the Ennie1 sample dominates with the sensory attributes of a light mouthfeel and an astringent aftertaste. At the upper-right of the biplot graph, the Dandang sample exhibits characteristics of sensory attributes such as rose aroma and rose flavor. At the lower-right of the biplot graph, the Pucuk and Gamboeng samples have sensory characteristic of light mouthfeel and astringent aftertaste with low intensity. At the lower-left of the biplot graph, the Heizl sample has characteristics of sensory attributes related to the yellow-brown brew color.

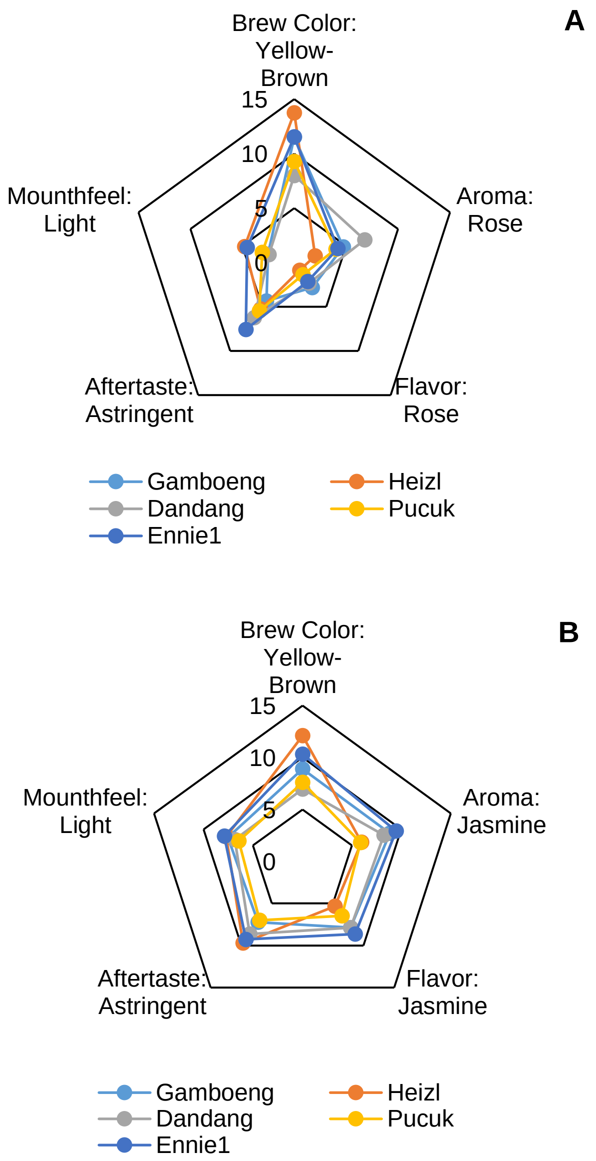

Figure 3. Spiderweb graph of white tea by trained panelist (A) untrained panellist (B)

The spiderweb graph is used to observe the intensity of attributes in the test samples. Based on Figure 6A, there is a high intensity in the yellow-brown brew color for the Heizl sample. High intensity in the rose aroma was identified in the Dandang sample. High intensity in the rose flavor was identified in the Dandang sample. High intensity in astringent aftertaste was identified in the Ennie1 sample and high intensity in light mouthfeel was identified in the Heizl sample.

Figure 4. Sensory evaluation of white tea using a virtual reality device

The correlation relationship between sensory attributes and the five samples of untrained panelists is presented in the principal component analysis (PCA) biplot graph, as shown in Figure 5B. Figure 5B illustrates two primary components of the research results, namely F1 (52.45%) and F2 (33.15%), which can explain 85.60% of the diversity of the data. The farthest point in Figure 5B represents the jasmine aroma, making it the most significant attribute compared to others. At the upper-left of the biplot graph, there is the Ennie1 sample with characteristics of yellow-brown brew color, an astringent aftertaste, and a light mouthfeel. At the upper-right of the biplot graph, contains the Gamboeng sample dominating the sensory attributes of jasmine aroma and jasmine flavor. At the lower-right of the biplot graph includes the Pucuk and Dandang samples with sensory characteristic of yellow-brown brew color, astringent aftertaste, and light mouthfeel with low intensity. At the lower-left of the biplot graph features the Heizl sample with sensory characteristic of jasmine aroma and jasmine flavor with low intensity.

The intensity of attributes by untrained panelists in Figure 6B shows a high intensity of yellow-brown brew color in the Heizl sample. High intensity of jasmine aroma and jasmine flavor in the Ennie1 sample. High intensity of aftertaste astringent and mouthfeel light in the Ennie1 sample. The evaluation of each sample by trained and untrained panelists in the PCA biplot graph and spider web diagram indicates differences in intensity due to varying levels of sensitivity and ability to identify.

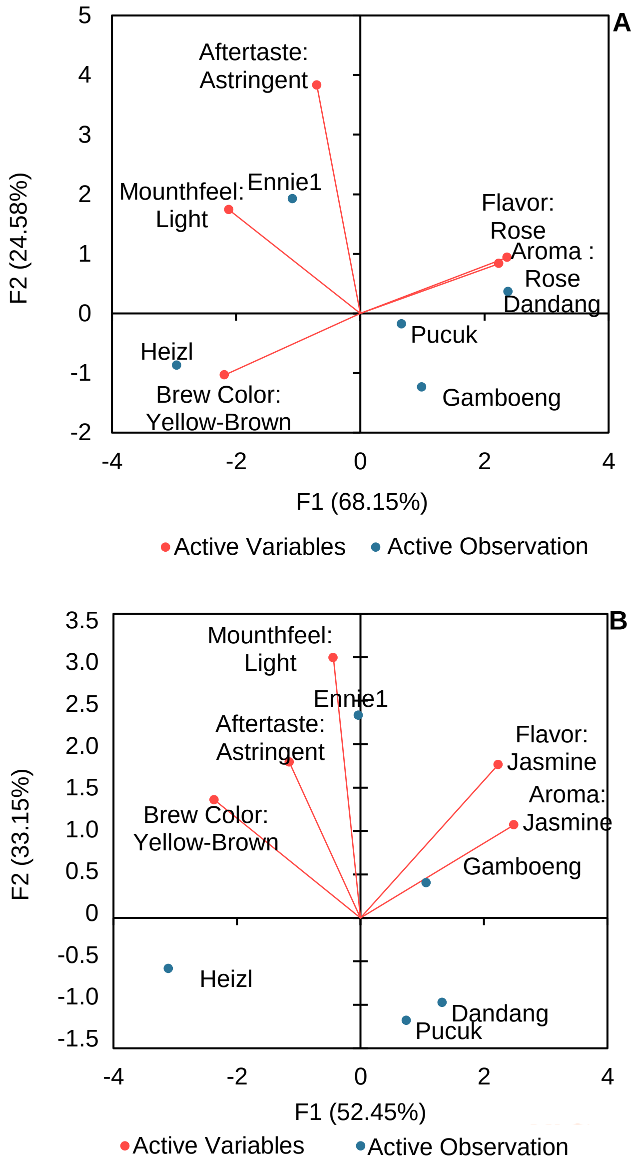

Figure 5. PCA biplot graph of HITS immersive approach by trained panelist (A) untrained panelist (B)

Comparison of dominant sensory attributes of white tea utilizing normal HITS modified and immersive HITS modified approach

The intensity of sensory attributes, specifically rose aroma and rose flavor, increased in all five samples when evaluated by trained panelists using virtual reality with riverside natural scenery visualization compared to laboratory evaluation, as depicted in Figure 7. In Figure 7, the intensity of light mouthfeel increased for the Gamboeng, Dandang, and Pucuk samples when evaluated using virtual reality with riverside natural scenery visualization compared to laboratory evaluation. On the other hand, the astringent aftertaste, which is an undesirable consumer sensory attribute, exhibited a decrease in intensity for all five samples when evaluated using virtual reality with riverside natural scenery visualization compared to laboratory evaluation. The farthest point in the sensory evaluation by trained panelists in the laboratory was the astringent aftertaste, while in virtual reality with riverside natural scenery visualization, it was the rose aroma.

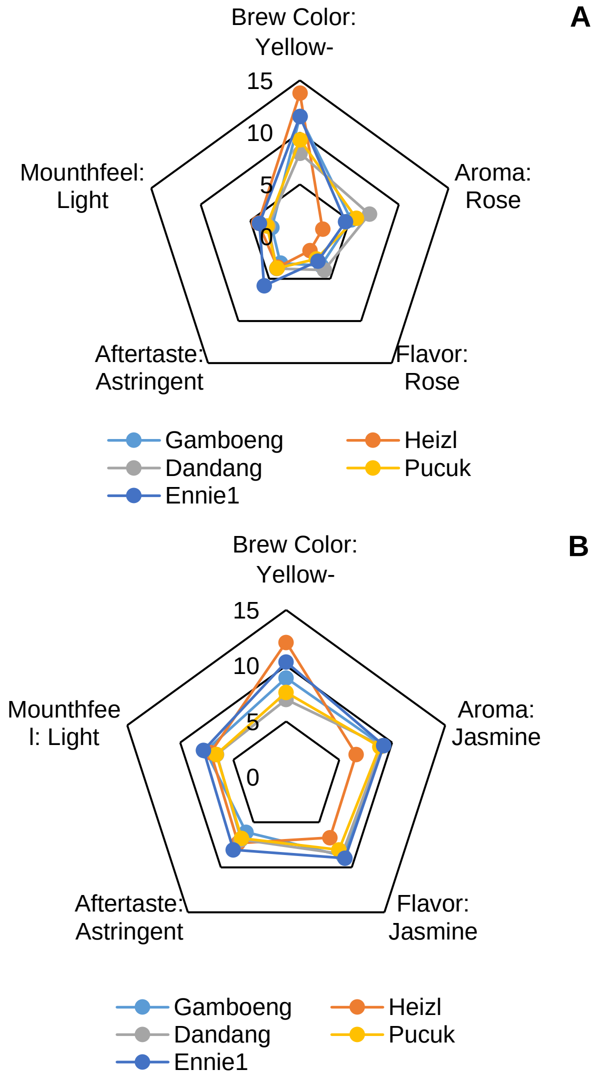

Figure 6. Spiderweb graph of HITS immersive approach by a trained panelist (A) untrained panelist (B)

In untrained panelists, the intensity of jasmine aroma in Gamboeng, Heizl, Dandang, and Pucuk samples increased when evaluated using virtual reality with riverside natural scenery visualization compared to laboratory evaluation (Figure 8). In Figure 8, the intensity of the jasmine flavor evaluated using virtual reality with riverside natural scenery visualization increased compared to laboratory evaluation. The intensity of mouthfeel in Dandang and Pucuk samples increased when evaluated using virtual reality with riverside natural scenery visualization compared to laboratory evaluation. The intensity of an astringent aftertaste in all five samples decreased when evaluated using virtual reality with riverside natural scenery visualization. The farthest point in sensory evaluation by untrained panelists in the laboratory was the jasmine flavor, while in virtual reality with riverside natural scenery visualization, it was the jasmine aroma.

Sensory evaluation using virtual reality can enhance the assessment of sensory attribute intensity, but it does not provide a preference level (Giezenaar and Hort, 2021). Sensory evaluation using virtual reality with riverside natural scenery visualization influences intensity, so sensory evaluation of white tea in modified natural environments elicits a positive response for intensity. The conducted research did not assess the level of preference. Sensory evaluation using virtual reality in a natural environment with riverside natural scenery visualization has an impact on in-tensity; making drinking tea with environmental modi-fications through virtual reality yields positive res-ponses for intensity. The positive environment used for virtual reality is associated with pleasant emotional terms, including cheerful, affectionate, enjoyable, happy, and joyful. Panelists engage in transferring emotions to the samples (Wang and Spence, 2018).

The comfort of the dining environment can positively influence sensory perception and consumer emotional responses. Mood has a significant influence on how individuals perceive the world around them, and a positive mood encourage global, flexible, intuitive, and holistic information processing. Negative moods are associated with more systematic, focused, and analytical processing, which may explain differences in purchasing intentions in negative environmental conditions. Negative VR environments are related to negative emotional terms such as disgust, guilt, boredom, and nostalgia (Torrico *et al.,* 2020).

CONCLUSION

The use of the high identity traits (HITS) method by the trained panelist resulted in five dominant attributes, *i.e*. the yellow-brown brew color, rose aroma, rose flavor, astringent aftertaste, and light mouthfeel. The untrained panelist resulted with five dominant attributes, *i.e*. the brew color yellow brown, jasmine aroma, jasmine flavor, astringent aftertaste, and light mouthfeel. The evaluation of HITS with an Immersive approach using natural virtual reality with visualization of riverside views showed the influence of the intensity of the dominant attributes of white tea. The intensity of aroma, flavor, and mouthfeel increased, while the astringent aftertaste decreased for both trained and untrained panelists due to the influence of emotional responses from the panelists.

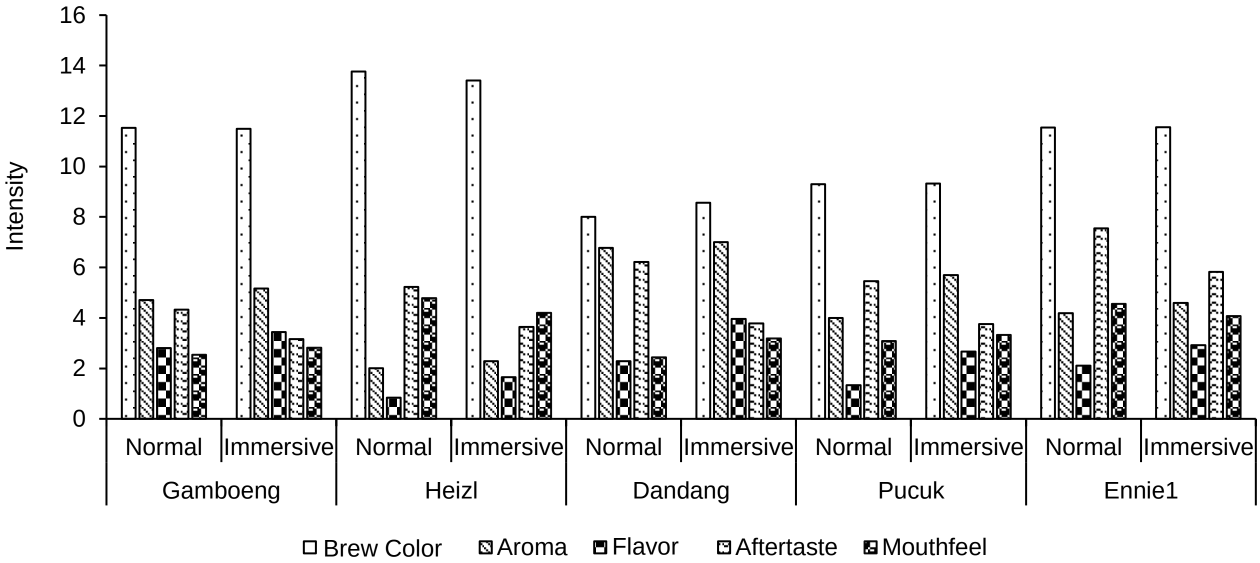

Figure 7. Histogram graph of intensity for a standard and immersive trained panelist

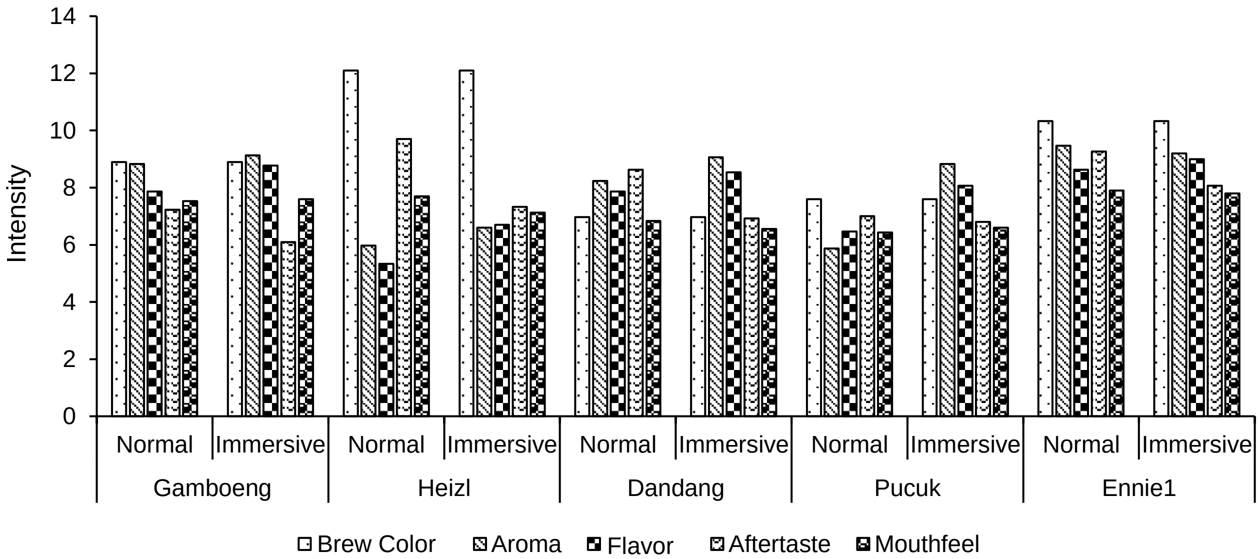

Figure 8. Histogram graph of intensity for a standard and immersive untrained panelist

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