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Characterization of physicochemical properties and sensory profile of commercial sorghum crystal sugar (*Sorghum bicolor* L)

Mirlanda, Dede Robiatul Adawiyah* and Dias Indrasti

Department of Food Science and Technology, Faculty of Agricultural Engineering and Technology, IPB University, Bogor, 16680, Indonesia

Abstract

Sorghum crystal sugar has the potential as an alternative healthy sugar with low-glycemic index that can be consumed by diabetics or dieters. This study aimed to characterize the physicochemical and sensory properties of sorghum sugar based on consumer preferences. Three samples of sorghum crystal sugar from producers with health department licenses and halal certification for physicochemical and sensory analysis. The physicochemical results showed that the three sorghum sugar products had higher moisture content, ash content, and reducing sugars but lower sucrose content and lower solution pH value compared to commercial sucrose. The relative sweetness levels of samples 983, 782, and 661 compared to a 7.50% sucrose reference solution were 0.95, 0.92, and 0.91 using the magnitude estimation method. Sensory profiling was conducted using the Check-All-That-Apply (CATA) and Rate-All-That-Apply (RATA) methods. The CATA results indicated that the panelists perceived sorghum sugar to have sensory attributes such as sweet taste, sweet aroma, sweet aftertaste, and burned caramel. Sample 983 was the closest to the ideal sorghum crystal sugar, and there was no significant correlation between sensory attributes and panelists preferences at the 5% significance level. In the development of sorghum crystal sugar, undesirable sensory attributes include burnt scorched, bitter, sticky, amber, wet earthy, and burnt sugar aftertaste. Sample 983 was the most preferred among the three samples, with a liking score of 4.06 and a profile of sweet aroma, gritty, and sweet aftertaste. Sample 782, with a liking score of 3.76, was characterized by attributes such as wet earthy, burned caramel, burnt sugar aftertaste, amber, and sweet aroma. Meanwhile, sample 661 received the lowest liking score of 3.52, with sensory attributes of bitter, burnt scorched, sour fermented, bitter aftertaste, cereal, and sticky.

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Sorghum, Physicochemical, Sensory Profile, Magnitude Estimation, CATA, RATA.

1. Introduction

One of the current growing trends is the increasing demand for natural sweeteners as an alternative to sugarcane amid concerns about the impact of refined sugar on health, such as diabetes. Sugar from the sorghum plant has emerged as one of the alternative choices among the many potential natural sweeteners. Sorghum plants (*Sorghum bicolor* (L.) Moench) are currently a commodity that is being promoted by the government in the context of food diversification because they are multipurpose plants where sorghum seeds, leaves, and stems can be used as primary products (directly) or derivatives and have wide adaptability, tolerance to drought, and high productivity (1).

The use of sorghum plant residues after harvesting the seeds, which are usually used as sorghum rice, sorghum flour, and sweet soy sauce, is mostly only used as compost or animal

* Correspondence: **Dede Robiatul Adawiyah** dede_adawiyah@apps.ipb.ac.id

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feed. Sorghum plant stems, especially sweet sorghum varieties, contain high sugar content, which can be used as a source of natural sweeteners (1). Previous studies indicate that the phenolic compounds in sweet sorghum juice possess strong antioxidant activity with potential health benefits (2). These phenolics have also been reported to exhibit antimicrobial functions, further highlighting the bioactive value of sweet sorghum (3). Sorghum crystal sugar has a unique composition, containing micronutrients such as potassium, calcium, magnesium, and amino acids, and it has a low glycemic index of < 55 (4). Although sorghum sugar has been widely promoted as a healthier and lower-calorie alternative to refined sugar, limited studies have compared the physicochemical and sensory properties of commercial sorghum crystal sugar products currently available in the market. This study addresses this research gap by providing comparative data and exploring consumer-related sensory attributes to strengthen the positioning of sorghum sugar as a potential natural sweetener alternative for diabetics and calorie-conscious individuals.

Magnitude Estimation (ME) is a direct psychophysical scaling technique where panelists assign numerical ratings based on perceived sweetness intensity. Because it generates ratio-scale data that accurately reflects stimulus–response relationships, ME is considered one of the gold-standard methods for sweetness measurement (5). Sensory profile analysis is used to study product characteristics using humans as measurement instruments. Rapid sensory profile evaluations, such as Check-All-That-Apply (CATA) and Rate-All-That-Apply (RATA), require less training than traditional methods, but still produce high-quality data in identifying product sensory factors that influence consumer acceptance. CATA is a qualitative method that provides responses in the form of whether or not an attribute is felt in the sample, but does not determine the intensity of each attribute selected (6). So it was developed using the RATA method to describe consumer perceptions of how much intensity of attributes are felt to determine the characteristics of a product, so that differences between samples are known objectively (7). The existence of great potential for commercial sorghum crystal sugar in its development, this study aims to characterize the physicochemical and sensory properties of sorghum crystal sugar that are most preferred by consumers.

2. Materials and Methods

2.1. Materials

This study used three samples of commercial sorghum crystal sugar obtained from different producers through official e-commerce platforms. All products were certified by the Health Department (PIRT) and Halal-certified, representing Indonesian commercial products. Each sample was produced from *Sorghum bicolor* (L.) Moench stalks. The researcher coded the three samples of sorghum crystal sugar with codes 983, 782, and 661. The researcher also compared commercial sorghum crystal sugar to sucrose with code 336 as a reference to the golden standard of sweeteners in general. The tools used for this study were 25 ml plastic cups, label paper, trays, stationery, glassware, scales (Precisa ES 220A), refractometer (RX-5000 i-Plus), pH meter (Mettler Toledo SC S220), proselen cup, furnace (Muffle Furnace AP-IN), vacuum oven (Accu tep-09).

2.2. Characterization of Physicochemical

The physicochemical characterization of sorghum sugar includes moisture content (%), ash content (%) analyzed using AOAC (2012) procedures with the gravimetric method, solution pH (8), %brix with refractometer analysis (9), reducing sugar (%), and sucrose content, analyzed using the BSN (2008) procedures with the Luff Schrool method.

2.3. Characterization of Sensory Profile

2.3.1. Panelist Screening

In this study, consumer panelists were used based on SNI 01-2346 in 2006, with a minimum of 30 panelists. Panelists who passed the screening met the requirements, such as being 19-45 years old, healthy, not diabetic, not hypoglycemic, and not having dental disease and not refusing or objecting to sugar consumption to taste each sample.

The relative sweetness level testing of panelists from PT XYZ and IPB University students who had conducted sensory analysis, the total panelists was 40 people, 12 men and 28 women. The sensory profile testing of the CATA method, consumer panelists were 30 people from PT XYZ, with 17 women and 13 men. The RATA test involved 100 consumer panelists from PT XYZ and IPB University students, 35 men and 65 women. The sensory profile testing has the same characteristics as the sweetness level.

2.3.2. Focus Group Discussion (FGD)

FGD was conducted with the researcher as the panel leader, and there were eight consumer panelists as members who came from Master students of the Department of Food Science and Technology, IPB University, to discuss the sensory attributes obtained during the study. The FGD process involved smelling and tasting sorghum crystal sugar to discuss dominant attributes such as color, aroma, taste, mouthfeel, aftertaste, and overall liking. Table 1, shows 17 attributes that have been adjusted to commercial sorghum sugar and selected through FGD by a group of consumer panelists.

Table 1. List of sensory attributes used in sensory testing questionnaires.

Category	Sensory attributes	Definition
Aroma	Sweet	A sweet aroma
	Burned caramel	An aroma similar to burnt sugar, caramel, and molasses
	Sour, fermented	A sour aroma, like that of wine
	Wet, earthy	An aroma resembling damp, wet grass
	Burnt, scorced	An aroma like the smell of cigarette ash or smoke
	Cereal	An aroma similar to stale malt or grains
Flavour	Burned caramel	A taste resembling burnt sugar, caramel, or molasses
Taste	Sweet	A sweet taste, like that of sucrose
	Sour	A sour taste, similar to acetic acid or vinegar
	Bitter	A bitter taste, like that of caffeine
Aftertaste	Sweet aftertaste	A lingering sweet taste in the mouth after swallowing
	Burn sugar-aftertaste	A lingering burnt sugar taste in the mouth after swallowing
	Bitter aftertaste	A lingering bitter taste in the mouth after swallowing
Mouthfeel	Gritty	A sensation of coarse crystals in the mouth
	Sticky	A sticky sensation in the mouth
Crystal color	Amber	A yellow-brown crystalline color

2.3.3. Determination of Relative Sweetness Level

The panelists evaluated the relative sweetness levels of the three sorghum crystal sugar samples with various concentrations (4.00, 5.25, 9.38, and 12.00%), and a 7.50% reference solution was presented as a reference for the intensity (10). Samples were tasted by tasting directly from the cup provided and left in the mouth for 3 seconds before being swallowed, and assessing the intensity of the sweetness of the sample compared to the intensity of the sweetness of the reference solution. Panelists filled in the measurement results on a questionnaire presented using a 1 to 20 line scale. An intensity value of 10 is given to the reference solution, if it is sweeter than the reference the sample intensity value is more than 10, and vice versa (11). The results were calculated using the *Steven's Law* equation graph (5).

$$R = kS^n \quad (1)$$
$$\log R = n \log S + \log k \quad (2)$$

Theorem 1. Steven's law equation, where R represents the perceived intensity or response of the attribute, S represents the stimulus intensity, and n is the power law index, depending on the conditions and stimuli. **Theorem 2.** Steven's law is derived using a logarithmic equation to simplify the relationship between stimuli and response.

2.3.4. Sensory Profile using Check-All-That-Apply (CATA) and Rate-All-That-Apply (RATA) Methods

Consumer panelists conducted sensory evaluations of the samples, the first test was CATA, before tasting the samples, panelists were asked questions via a questionnaire form regarding the perception of the ideal product sensory profile by providing a check mark on the sensory attributes that were considered to be able to describe the ideal sorghum crystal sugar. Panelists were given samples (as eat or sugar in crystal form) of 5 grams each in a 25 mL cup, one glass of 240 mL mineral water as a mouthwash, and one cracker to remove the aftertaste when changing samples. Panelists evaluated the samples by indicating the sensory attributes they perceived and marking the relevant options from a predefined list on the questionnaire (12). Next, before conducting the RATA test, is the hedonic rating test by tasting each sample without comparing between samples. Panelists evaluate each sample with a 6-point preference scale (1= very dislike, 6= very like). RATA testing by providing a checklist on the questionnaire for each sample that describes the intensity of the attribute on a scale of 1-5 (very low to very high).

2.4. Statistical Analysis

Statistical data processing for the characterization of the physicochemical properties of sorghum crystal sugar was carried out using one-way ANOVA with Duncan's post-hoc test at a 5% significance level, utilizing IBM SPSS Statistics 22 software. For sensory profile characterization, XLSTAT 2020 and IBM SPSS Statistics 22 were used to obtain outputs such as Cochran's Q Test, biplot maps from Principal Component Analysis (PCA), spiderweb diagrams, and significance between attributes.

3. Results and Discussion

3.1. Characteristics of Physicochemical Properties

This study was to characterize the physicochemical properties of commercial sorghum crystal sugar, as shown in Table 2. The physicochemical results between the three sorghum crystal sugars and sucrose showed significant differences caused by the refining process, natural plant content, and different production methods. Sorghum crystal sugar has higher moisture, ash, and reducing sugar content, with lower solution pH compared to commercial sucrose. These yield variations affect the taste, texture, and potential use of the product, especially in terms of stability. High moisture content has the potential to accelerate product quality degradation and increase the risk of microorganism growth (8). Furthermore, the high reducing sugar content may influence the product's shelf-life and crystal texture. Reducing sugars are more hygroscopic and reactive, potentially accelerating browning reactions and affecting storage stability. Ash content is related to minerals or plant residues (13), the natural mineral composition of sorghum plants varies, resulting in more mineral residues during processing which may be beneficial from a nutritional perspective.

Table 2. Physicochemical results of commercial sorghum crystal sugar and sucrose.

Parameter	Samples			
	983	782	661	336
Moisture content (%)	1.34±0.30[b]	2.48±0.25[c]	1.54±0.09[b]	0.10±0.00[a]
Ash content (%)	0.16±0.14	0.22±0.17	0.26±0.19	0.10±0.00
Sucrose content (%)	96.94±0.00[c]	95.21±0.01[b]	85.68±0.01[a]	99.80±0.01[d]
Reducing sugar (%)	2.16±0.01[b]	2.73±0.01[c]	4.13±0.01[d]	1.60±0.01[a]
Brix (%)	9.66±0.00[c]	9.54±0.00[b]	9.51±0.01[a]	9.97±0.01[d]
pH of solution	6.25±0.00[b]	6.50±0.00[c]	4.99±0.02[a]	6.55±0.01[d]

Numbers followed by different letters indicate that the samples are significantly different at the 5% level based on Duncan's test.

The sucrose content in commercial sorghum crystal sugar is lower than sucrose due to the presence of other simple sugars are glucose and fructose, in addition to the extraction and refining processes are not as efficient as cane sugar to produce pure sucrose. The higher reducing sugar content in commercial sorghum crystal sugar compared to sucrose is influenced by the type of plant and the enzymatic decomposition process during processing. The non-sugar content and refining method affect the brix value and pH of the solution, where the lower total sugar concentration and natural acid content in sorghum plants may be formed during the fermentation or extraction process (8). The production processes for sorghum crystal sugar and sucrose differ significantly in terms of refinement and the materials used. Sorghum sugar is produced by extracting juice from sorghum stalks through milling, followed by boiling until it thickens, with minimal additional processing. This method retains more organic compounds and minerals, giving sorghum sugar its darker color and richer flavor. In contrast, sucrose production involves milling sugarcane stalks to extract the juice, which is then subjected to intensive refining steps, such as filtration, clarification using chemicals (like sulfur dioxide), and bleaching to remove impurities and natural coloring (14). These compositional and processing differences may also influence the metabolic response of the sugar when consumed. Although the glycemic index (GI) was not directly measured in this study, the results support the low-GI potential of sorghum crystal sugar as previously reported (4). The lower sucrose content and higher proportion of reducing sugars observed in this study may contribute to a slower glucose release and absorption rate compared to refined sucrose. Moreover, sorghum sugar retains more minerals, organic acids, and bioactive compounds such as polyphenols and tannins, which are known to inhibit α-amylase and α-glucosidase enzymes, thereby slowing carbohydrate digestion and moderating postprandial blood glucose response (4). Therefore, the chemical composition observed in this study provides supporting evidence for the previously reported low glycemic index characteristics of sorghum crystal sugar.

3.2. Characterization of Sensory Profile

3.2.1. Relative Sweetness Level

The relative sweetness level of commercial sorghum crystal sugar in this study used the magnitude estimation method with a psychophysical approach that correlation stimulus and response. Determination of the concentration of sorghum sugar solution when the panelists give a score of 10 is equivalent to a reference solution concentration of 7.50%. The results of determining the concentration of sorghum sugar solution can be obtained through the correlation equation between the sample concentration and the average sweetness score given by the panelists, with a logarithmic equation.

In Figure 1, it shows a graph of the logarithmic equation or Steven's Law to determine the concentration of the sample (x) when the panelists gave a score of 10 (y) (15). The linearity coefficient (R^2) value produced was good enough in the three samples (Table 1) so that the Steven's Law model was able to interpret the test data well, the R^2 value was in the range of 0 to 1. The closer R^2 is to the value of 1, the better of model (independent variable) used in explaining the dependent variable (15).

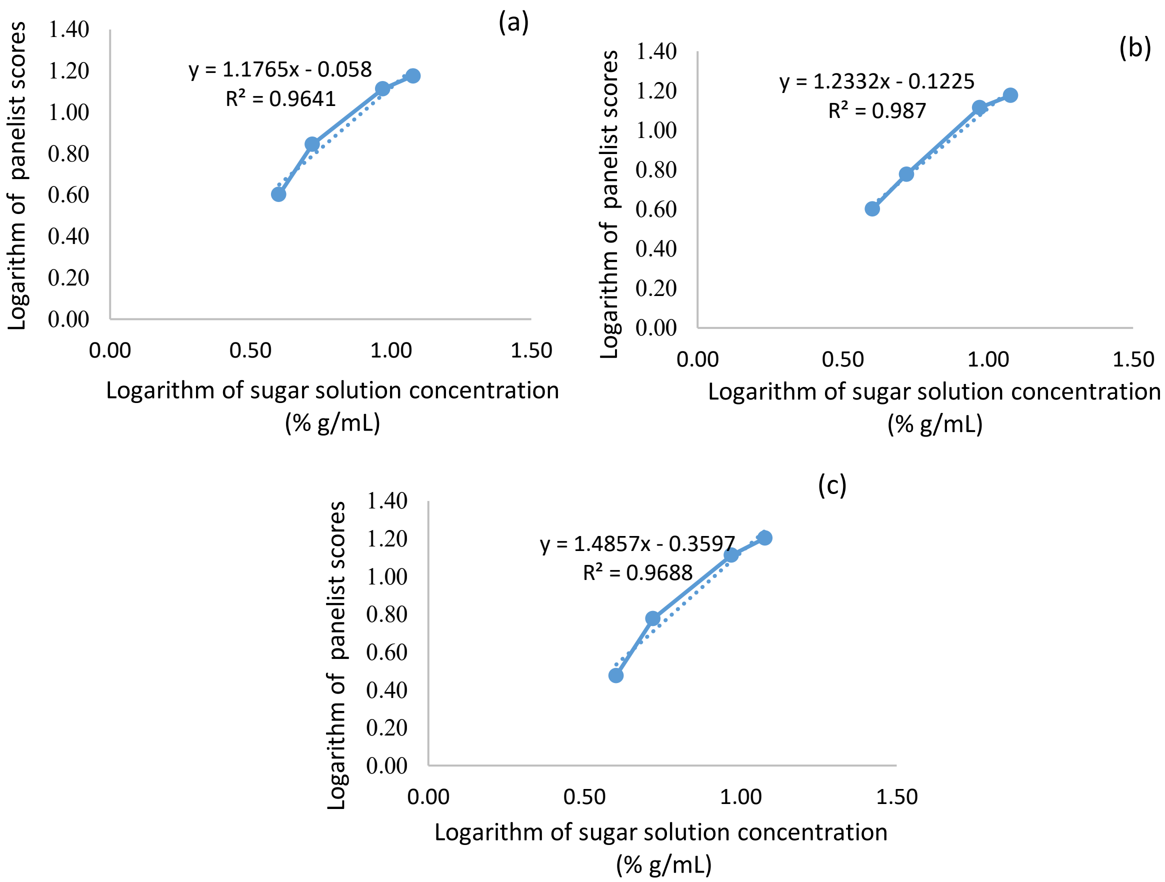

Figure 1. Logarithmic correlation graph of sorghum crystal sugar solution concentration with average sweetness score. (a) 983; (b) 782; (c) 661.

Based on Table 3, it shows that a higher concentration is needed to equalize the sweet taste stimulus provided by the 7.50% reference solution. The relative sweetness levels in the

Steven's Law model for samples 983, 782 and 661 are 0.95, 0.92, and 0.91. The results obtained from the three product samples were lower than the sweetness index of the sucrose solution against the reference solution of 7.50%. The components or composition of sorghum crystal sugar produce a complex and unstable taste, thus affecting the sweet taste in the panelist's response (16).

Table 3. Recapitulation of concentration and relative sweetness levels of commercial sorghum crystal sugar solutions.

Samples	Concentration to get a sweetness score of 10 (g/mL)	Sweetness relative index of 7.50% sucrose	R^2
983	7.93	0.95	0.9641
782	8.13	0.92	0.9870
661	8.23	0.91	0.9688

3.2.2. Sensory Profile using Check-All-That-Apply (CATA) Methods

The sensory characteristics of commercial sorghum crystal sugar and ideal sorghum crystal sugar were determined through Cochran's Q test and correspondence analysis. The Cochran's Q test, combined with multiple pairwise comparisons, compared each sensory attribute of commercial sorghum crystal sugar at a 5% significance level. Correspondence analysis represented ideal sorghum crystal sugar and commercial sorghum crystal sugar products in a biplot map, reflecting their sensory attributes (17). The results of the Cochran's Q test showed that all sensory attributes in each sample differed significantly at the 5% level, except for the attributes of sweetness and the gritty sensation.

The perception of the sensory profile of ideal sorghum crystal sugar is illustrated in the correspondence analysis map in Figure 2. No sweetener or sugar is truly ideal, but sucrose is considered the gold standard. Sensory-wise, an ideal sweetener should be as sweet as sucrose, with a clean taste and an immediate, pleasant onset that does not linger (18). This suggests that panelists can accept other sensory attributes, such as sweet aroma, sweet aftertaste, and burned caramel in the ideal sorghum crystal sugar. However, the sensory profile is inherently different from sucrose, as shown in the correspondence analysis map, where sucrose is characterized only by the attributes of sweetness and gritty sensation.

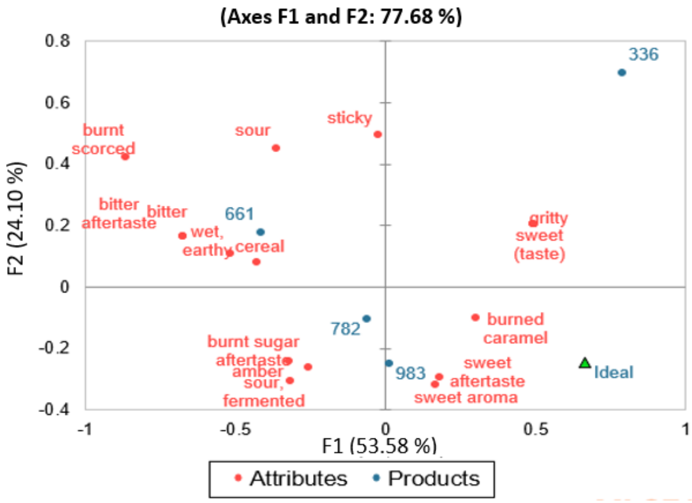

Figure 2. Representation of sensory profiles of commercial sorghum crystal sugar and ideal sorghum crystal sugar according to panelists.

The sample that comes closest to the ideal sweetener on the correspondence analysis map is 983. On the other hand, sample 661 is significantly distant from the ideal sorghum crystal sugar, exhibiting sensory attributes such as burnt scorched, bitter aftertaste, bitter, wet and earthy, cereal, sour, sticky, and an amber-brown crystal color. Identifying sensory attributes for product development can be done through penalty analysis, which identifies sensory attributes that either decrease or enhance product preference. The analysis is divided into three categories: must-have, nice-to-have, and must-not-have attributes (17). Penalty analysis applies the 20% Pareto cut-off theory, which states that 80% of the effects are caused by 20% of the causes (19).

The analysis of must-have attributes is based on P(No)|(Yes), which occurs when a sensory attribute is absent in commercial sorghum crystal sugar but desired in the ideal sorghum crystal sugar, and P(Yes)|(Yes), when the attribute is present in both. The average preference scores from these two conditions are compared, and the difference is termed mean drops (20). A sensory attribute qualifies as must-have if the P(No)|(Yes) condition exceeds 20% and the mean drops are positive. In Figure 3a, sweet aroma and sweet aftertaste have P(No)|(Yes) values above 20%, but their mean drops are negative (-0.395 and -0.366), indicating that no attribute qualifies as "must-have" for sorghum crystal sugar.

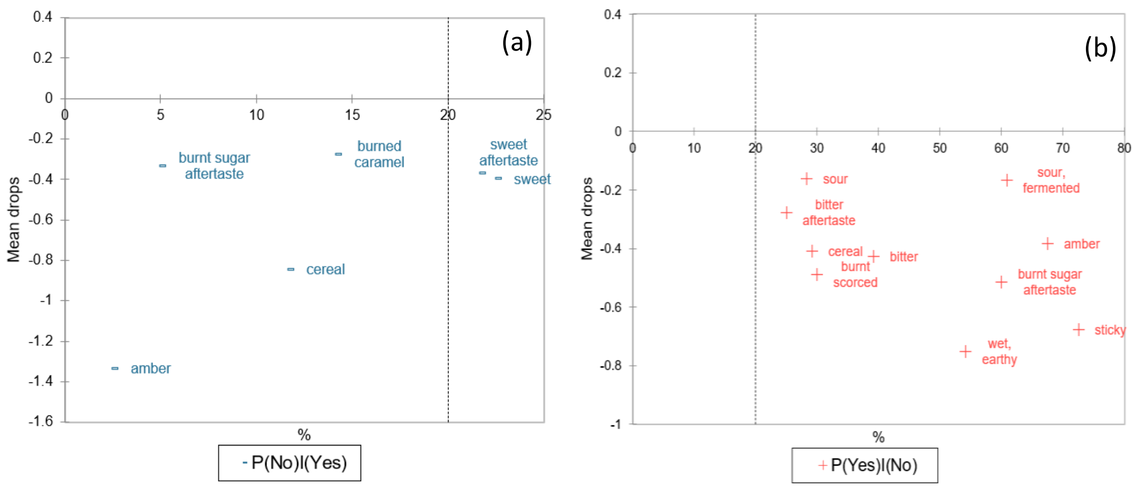

Figure 3. Analysis curve of attributes (a) must have in ideal commercial sorghum crystal sugar, (b) nice to have and must not have in ideal sorghum crystal sugar.

The attributes classified as nice to have and must not have are the opposite of must have attributes. These attributes are present in the actual product but absent in the ideal sample. Nice to have attributes increase preference, while must not have attributes decrease preference. If P(Yes)|(No) exceeds 20%, attributes with positive mean drops fall under the nice to have category, and those with negative mean drops are considered must not have (20). In Figure 3b, there are no attributes classified as nice to have because all attributes with P(Yes)|(No) values above 20% have negative mean drops. Attributes like burnt scorched, bitter, sticky, amber, wet earthy, and burnt sugar aftertaste are identified as must not have, as their presence, though recognized by the panelists, reduces the preference for the product.

3.2.3. Sensory Profile using Rate-All-That-Apply (RATA) Methods

The perception of the correlation between sensory attributes as variables and commercial sorghum crystal sugar and sucrose as objects can be represented by a biplot. Biplot graph provides crucial information, such as the proximity of objects and the variability of a variable. The closer the distance between a variable and an object in the graph, the stronger the involvement or characteristic association of a sample (21). The correlation between sensory attributes in the sample is shown in the biplot of principal component analysis (PCA), as seen in Figure 4. Based on the eigenvalues, the PCA biplot on two main components F1 (75.59%) and F2 (20.49%) explains 96.08% of the data variance. The good PCA graph should explain at least 70% of the data variance, indicating that this graph is highly reliable (22).

Samples with attributes located close to each other on the biplot share similar descriptions and exhibit a positive correlation, while those farther apart or located in different quadrants indicate a negative correlation or no correlation at all. In Figure 4, the biplot illustrates the correlation between four sugar samples, three commercial sorghum crystal sugars and one comparison sample, sucrose (983, 782, 661, and 336) with the sensory attributes measured.

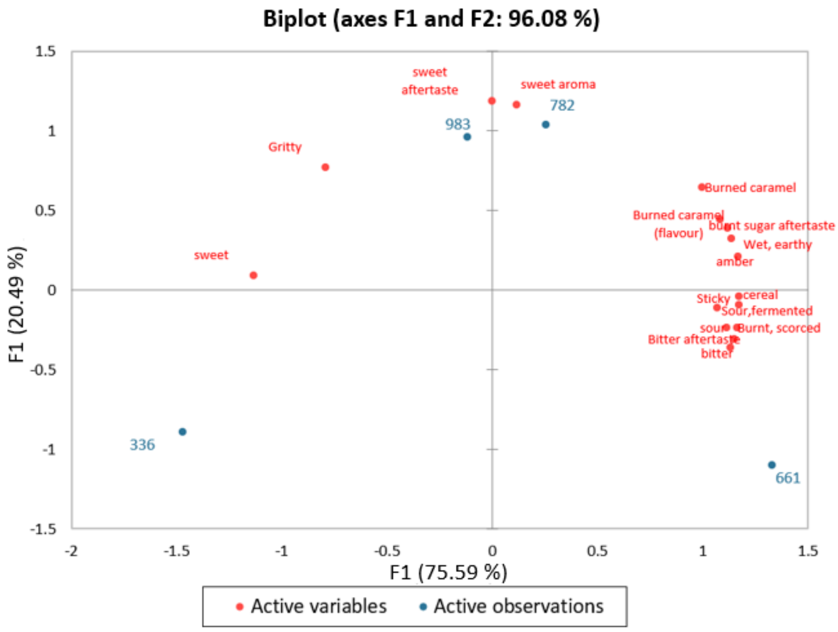

Figure 4. PCA biplot graph (96.08%) according to consumer panelists.

The attribute of sweetness shows a strong association with sample 336, located in the lower-left quadrant and distant from other attributes. This indicates that sample 336 is more dominant in sweetness without many additional sensory characteristics. Attributes such as sour, sticky, burnt scorched, bitter, cereal, sour fermented, and amber are positioned in the lower-right quadrant for sample 336, indicating a strong correlation, suggesting a more complex flavor profile with negative tendencies that may affect consumer preference. Sample 782 is located in the upper-right quadrant, showing a strong correlation with positive attributes like sweet aroma and sweet aftertaste, while sample 983, in addition to sweet aftertaste and sweet aroma, also has the attribute of gritty sensation. The perception of sweetness intensity appears to increase when the intensity of attributes like sour, sticky, burnt scorched, bitter, cereal, sour fermented, and amber undergoes a reduction in intensity.

Based on Table 4, the one-way ANOVA with Duncan's post-hoc test at the 5% level, the significance of each sensory attribute profile can be identified. The attributes of sweet aroma, burnt scorched, cereal, burned caramel, sweet (taste), bitter, sweet aftertaste, and bitter aftertaste are perceived to have no significant differences between samples 983 and 782. The sweet taste attribute has the highest intensity or is dominant in sucrose and is perceived with the lowest intensity for most other attributes, with significant differences. The attributes burnt scorched, amber, sticky, bitter aftertaste, burnt sugar aftertaste, bitter, sour, and burned caramel show the highest intensity in sample 661 and differ significantly from the other three samples.

Table 4. Significance of liking and attributes between samples based on one-way ANOVA with Duncan's post-hoc test at a 5% significance level.

Attributes	Samples			
	983	782	661	336
Liking	4.06^{c}	3.76^{b}	3.52^{a}	5.01^{d}
Sweet aroma	3.61^{c}	3.50^{c}	3.01^{b}	0.29^{a}
Burned caramel	3.69^{bc}	3.55^{b}	3.96^{c}	0.80^{a}
Sour, fermented	2.30^{b}	2.72^{c}	3.30^{d}	0.60^{a}
Wet, earthy	3.00^{b}	3.40^{c}	3.14^{bc}	0.35^{a}
Burnt, scorced	2.32^{b}	2.49^{b}	3.36^{c}	0.37^{a}
Cereal	2.42^{b}	2.38^{b}	3.23^{c}	0.65^{a}
Burned caramel (flavour)	3.42^{b}	3.49^{b}	4.11^{c}	0.91^{a}
Sweet	3.67^{b}	3.84^{b}	3.24^{a}	4.27^{c}
Sour	1.59^{b}	2.05^{c}	2.46^{d}	0.88^{a}
Bitter	1.50^{b}	1.67^{b}	2.39^{c}	0.91^{a}
Sweet aftertaste	3.58^{c}	3.63^{c}	3.13^{b}	0.52^{a}
Burnt sugar aftertaste	3.13^{b}	3.62^{c}	3.75^{c}	0.70^{a}
Bitter aftertaste	1.70^{b}	1.97^{b}	2.89^{c}	0.82^{a}
Gritty	2.98^{b}	3.33^{c}	2.22^{a}	3.11^{bc}
Sticky	1.67^{b}	2.00^{c}	2.11^{c}	0.48^{a}
Amber	3.26^{b}	3.76^{c}	4.72^{d}	0.93^{a}

Numbers followed by different letters indicate that the samples are significantly different at the 5% level based on Duncan's test.

Based on the spiderweb graph in Figure 5, it can be concluded that, overall, the profiles of samples 983 and 782 are similar, whereas the profile of product 661 differs from the group, exhibiting attributes with high average intensities that tend to be negative. The attributes arising from sorghum crystal sugar are highly distinctive and complex, unlike sample 336, which is dominated solely by the sweet taste and gritty sensation due to differences in raw materials and production processes.

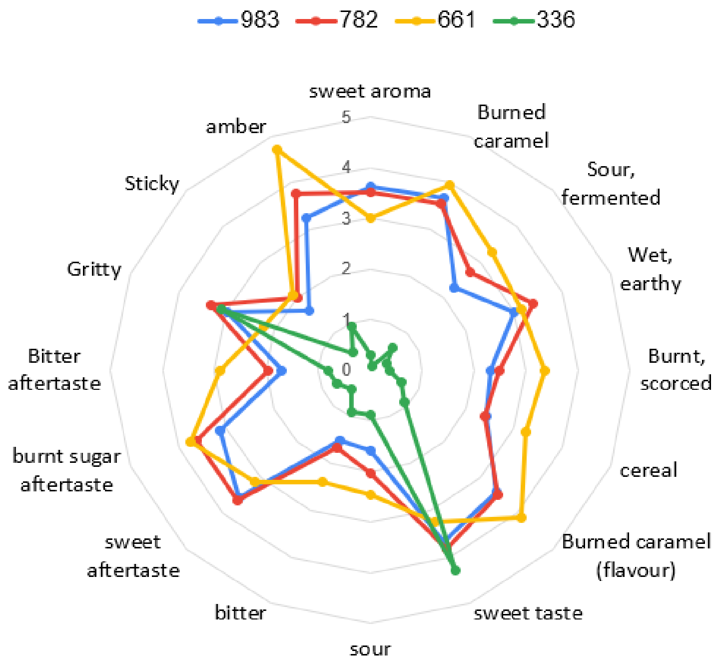

Figure 5. Spiderweb of sorghum sugar crystal commercial and sucrose.

The hedonic rating test aims to determine the panelists' preference level for commercial sorghum crystal sugar based on its overall attributes. The results of the hedonic rating test revealed significant differences among the four products. Sucrose received the highest rating of 5.01, indicating it was liked on a 1-6 scale, which is due to the absence of dominant negative attributes. Following this, sample 983 received a score of 4.06, meaning it was somewhat liked, followed by 782 with 3.76, and 661 with 3.52, indicating it was somewhat disliked. Based on the sensory profile assessment of the three commercial sorghum crystal sugars, sample 983 had the profile most preferred by the panelists, as shown in Table 4.

4. Conclusions

The research results indicate that commercial sorghum crystal sugar has higher moisture content, ash content, and reducing sugars, with a lower pH compared to commercial sucrose. The relative sweetness levels of samples 983, 782, and 661 compared to the 7.50% sucrose reference solution were 0.95, 0.92, and 0.91, respectively, using the magnitude estimation method. Sample 983 closely aligns with the profile of ideal sorghum crystal sugar, though no sensory attribute significantly influenced its preference. Attributes such as burnt scorched, bitter, sticky, amber, wet earthy, and burnt sugar aftertaste should be avoided in product development as they may reduce consumer liking. Sample 983 was the most preferred among the other samples, with a liking score of 4.06 and a profile characterized by sweet aroma, gritty texture, and sweet aftertaste. Sample 782, with a liking score of 3.76, exhibited attributes such as wet earthy, burned caramel, burnt sugar aftertaste, amber, and sweet aroma. Meanwhile, sample 661 received the lowest liking score of 3.52, characterized by a sensory profile of bitter, burnt scorched, sour fermented, bitter aftertaste, cereal, and sticky.

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Author Contributions

R.T and N.P.L contributed reagents, materials, analysis tools; D.R.A and D.I.N as supervising lecturers.

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Institutional Review Board Statement

The human research protocol was approved by the IPB University Commission on Research Ethics Involving Human Subjects (number 1378/IT3). KEPMSM-IPB/SK/2024.

Data Availability Statement

Data Available data was presented in the manuscript.

Conflicts of Interest

Authors may declare no conflict of interest.

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