

## Sensory Analysis of Chocolate Milk for College Students

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### Abstract

The study explores the impact of varying levels of added sugar on the sensory characteristics of chocolate milk. Chocolate milk formulations were studied with five levels of added sugar (g): 0 (A), 7 (B), 14 (C), 21 (D) and 28 g (E) in 237 mL of chocolate milk. For Ranking Descriptive Analysis (RDA), the panel was composed of 15 assessors. The acceptance was evaluated by 190 assessors. Sample discrimination was correlated with sweetness flavor, texture, sweet aroma, chocolate flavor and creamy appearance. It was observed that attributes like sweet aroma, sweetness and texture showed a significant difference among the samples. Formulations C, D and E got higher grades 4 and attributes for milk A and B were less acceptable mainly regarding flavor and texture. The data showed that the samples containing the highest concentrations of added sugar were more preferred than those with lower sugar levels.

**Keywords:** Sensory Analysis; Sucrose; Consumer

### Introduction

Milk and dairy products are important components of many diets based on the nutrients they contain, including calcium and vitamin D [1]. Eduardo and Lannes [2] reported that chocolate is eaten in many parts of the world by people of all ages and social classes, in many forms, ranging from powders to flavored milk. Murphy *et al.* [3] reported the positive effect of flavored or plain milk consumption on nutrient intake. Chocolate milk has a higher calorific value than the natural product. For the added calories not to discourage milk consumption and all its benefits, Li *et al.* [4] advised reducing the sugar content of chocolate milk as much as possible while still maintaining acceptability among consumers.

Ranking tests are usually employed to compare multiple samples with different intensities of a given attribute [5]. Some studies have explored the use of a ranking procedure with a descriptive purpose [6,7] and in such cases, it is recommended to involve at least 15 judges [8]. Richter *et al.* [7] proposed the method Ranking Descriptive Analysis and reported that it allowed the discrimination of the samples studied (chocolate pudding) with similar efficiency to the traditional descriptive ones.

According to Carnelocce *et al.* [9], the Ranking Descriptive Analysis offers the standardization of scale extremes and the selection of judges and possible training repetition. The authors also highlighted that RDA reduce the time and cost of a product in the description, to the extent that requires fewer and smaller amounts of sessions for each sample.

The acceptance tests are used to evaluate how much consumers like or dislike the product [10], with important complementary information to the product description to assess whether a sensory characteristic impacts consumer acceptance.

The objective of this research was to study the sensory characteristics of chocolate milk formulations with varying levels of sugar to ascertain how sugar affects the preference of chocolate milk.

### Materials and Methods

#### Sample preparation and conditions of sensory tests

Chocolate milk formulations were prepared using sterilized skimmed milk and cocoa powder, 2g per 100 mL of milk. Five concentrations of added sugar were studied: A=0, B=7, C=14, D=21 and E=28 g in 237 mL of chocolate milk. The samples were served in transparent cups (50 mL) at 7 °C and coded with random-three digit numbers and at natural lighting. The tests were

performed in the Sensory Analysis Laboratory, Federal University of São Carlos. The project was approved by the Ethics in Human Research (number 0143.0.268.000-09).

## Ranking Descriptive Analysis (RDA)

For Ranking Descriptive Analysis (RDA) [7] a panel of 15 judges was used. Initially, a survey of attributes was conducted using the repertory method [11]. Each judges described similarities and differences between the samples regarding to appearance, aroma, flavor and texture.

A qualitative inquiry was then undertaken to determine the most cited descriptive terms and develop a list of consensus descriptors, as well as a glossary. It was defined that attributes cited by more than 50% by the judges. Sample evaluation by RDA was completed in one session. The samples were simultaneously presented and each assessor ordered samples in ascending order of intensity for each of the attributes.

## Acceptance test

Sample acceptance was evaluated by a panel of 190 students between ages 18 and 25. The samples were evaluated for appearance, aroma, flavor, texture and overall acceptance using a seven-point scale. The presentation order of the samples was monadic and sequential, following a balanced complete blocks design [12].

## Analysis of the results

Ranking results were evaluated by the Friedman test [13] at a 5% significance level. Acceptance data was analyzed by analysis of variance, considering sample and judge as sources of variation, followed by Tukey's test at a 5% significance level and internal preference maps were generated using the R software system [14].

## Results and Discussion

### Ranking Descriptive Analysis

The following attributes were selected (number of times cited by the 15 judges): brown color (10), creamy appearance (8), chocolate flavor (8), sweet aroma (15), chocolate taste (8), sweetness (15) and texture (14). Studies described by Pflanzler *et al.* [15] noted attributes such as brown color, chocolate flavor, sweetness and texture.

Chocolate milk	Brown Color		Creamy Appearance		Chocolate Flavor		Sweet Aroma		Chocolate Taste		Sweetness		Texture	
A	45	a	40	a	41	a	28	b	33	a	17	d	29	b
B	46	a	42	a	43	a	39	ab	42	a	33	cd	39	ab
C	43	a	46	a	50	a	47	ab	38	a	44	bc	45	ab
D	45	a	44	a	41	a	50	ab	55	a	61	ab	55	a
E	46	a	53	a	51	a	61	a	57	a	70	a	57	a

\*Sums followed by the same letters did not differ significantly from each other by the critical values of Newell and MacFarlane (1987) at a 5% significance level (15 judges; critical value: 24). A=0 g, B=7 g, C=14 g, D=21 g and E=28 g of added sugar in 237 mL of chocolate milk

**Table 1:** Characterization of the samples by RDA

It was found that the attributes sweet aroma, sweetness, chocolate taste and texture showed significant difference among the samples (Table 1); therefore, the change in the proportion of sugar did not result in differences in the perception of brown color, creamy appearance and chocolate taste. For the attributes sweet aroma and chocolate flavor, samples A and E showed a significant difference, but no difference was detected among the others.

Evaluating attribute by attribute, it was found that the samples without sugar (A) and at the 12% level (E) differ significantly in relation to flavor and sweet taste, chocolate flavor and texture. The discriminating attribute allowed texture for sample without sugar 21 g (D), but no difference in texture was observed with increasing addition of sugar until 28 g. Sweet taste showed the greatest difference, with a significant discrimination between the sample without sugar (A) and the samples above, with 14 g (C, D and E).

### Acceptance of milk with chocolate

Table 2 shows there was a variation in the acceptance of all samples regarding all attributes. In Figure 1, the two principal components account for 64.35% of the variation in the acceptance of the chocolate samples compared to color. PC1 component, which explains the greatest variation of acceptability of the color attribute (37.93%), spatially separates the samples on the left of its axis (less preferred samples for color) and on the right of its axis (most preferred samples for color) (Figure 1).

Chocolate milk*	Color		Aroma		Flavor		Texture		Global acceptance	
A	4.5	b	4.2	c	2.0	d	3.4	d	2.6	d
B	4.8	a	4.5	b	3.1	c	3.9	c	3.6	c
C	5.0	a	4.8	a	4.4	b	4.5	b	4.5	b
D	5.1	a	5.0	a	5.0	a	4.8	a	5.0	a
E	5.2	a	4.8	a	5.1	a	4.9	a	5.0	a

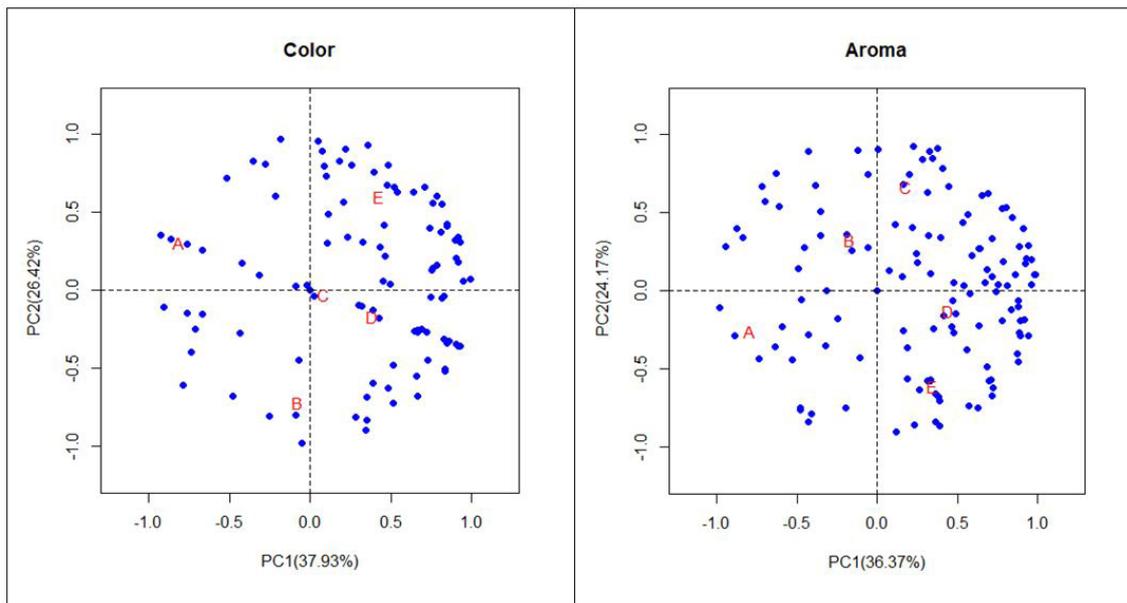
A=0 g, B=7 g, C=14 g, D=21 g and E=28 g of added sugar in 237 mL of chocolate milk

Panel of 190 assessors. 1: I dislike very much to 7: I like very much

Values followed by the same letter in the column do not differ significantly in the test at a 5% significance level

**Table 2:** Acceptance for chocolate milk formulation

In the inner map of preference for aroma, the first and second principal components account for near range of values, together totalizing 60.54% (Figure 1). The aroma for samples C, E, D was further assessed, and compared to judges PC1 values of the samples B and A.

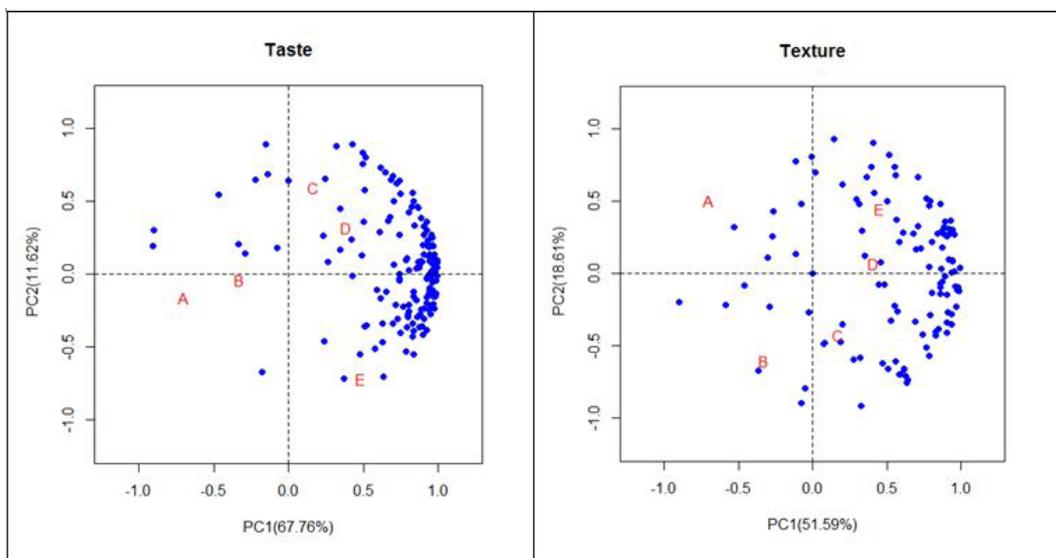


**Figure 1:** Internal preference map for the five chocolate samples in relation to: (a) color; and (b) aroma

In relation to the internal map of preference for the flavor of the chocolate samples, the two components explained 79.38% of the variation that exists among samples, and the first principal component explains 67.76% of the variation (Figure 2).

Samples D and E had the most popular taste among the judges, which did not occur with samples B, C and A.

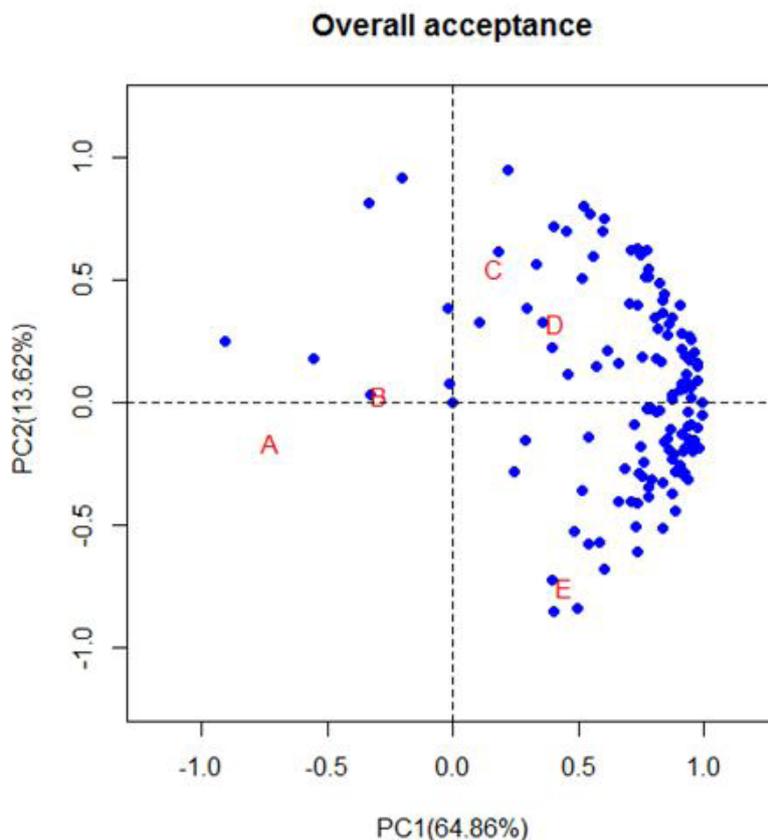
Regarding texture, the first principal component (PC1) explains 51.59% of the total variation of 70.2% that exists between samples (Figure 3).



**Figure 2:** Internal map of preference for five chocolate samples in relation to: (a) taste; and (b) texture

Again, samples C, D and E had the highest scores for texture, since samples A and B had the smallest notes, where 1 remained virtually isolated from the rest of the samples.

Regarding the overall acceptance of the chocolate samples, the preference map explains 78.48% of the total variation related to this attribute, being 64.86% of the total variation explained by the first principal component (PC1) and 13.62% by the second (PC2) (Figure 3). Samples E, D and C were the most preferred and samples A and B, the least preferred.



**Figure 3:** Internal map of preference for five chocolate samples in relation to the overall acceptance

For the attributes color and aroma, the sample without sugar was the least accepted; nonetheless, on a 7-point scale, there were more than 4 notes. For attributes flavor and texture, samples D and E were the most accepted and sample C showed notes 4.3 to 4.5 for flavor and texture, standing on the same scale as samples D and E. Considering a 7-point scale, it can be stated that there was no rejection of sample C, indicating that the concentration of 14 g was also satisfactory. According to Cândido and Campos [16], sucrose helps giving texture to food, justifying the increased acceptance of the judges for texture.

## Conclusion

The influence of flavor and texture was also checked in the global acceptance of the samples. From the sensory profile and evaluation of consumer acceptance, we identified important attributes, such as flavor and texture, which directed the preference of the judges, who accepted the milk with lower amounts of sugar. The data showed that the samples containing the highest concentrations of added sugar were more preferred than those with lower sugar levels.

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