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Word association and check-all-that-apply accessing the difference between yogurt and fermented whey beverage

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ABSTRACT. Consumers see whey beverages as inferior products to yogurts, especially regarding texture and viscosity. The aim of this work was to evaluate consumers' perception of the differences between yogurt and fermented whey beverage using word association and check-all-that-apply (Cata). Untrained assessors (n = 100) evaluated samples of three commercial brands of liquid or stirred yogurt and whey beverage, of strawberry flavor. Chemical and physical parameters (pH, acidity, total solids, color, texture and syneresis) were determined to assist in the interpretation of the results. The study showed that physical and chemical characteristics were inherent to each product, with no homogeneity within each category. The texture was the parameter that most influenced consumer responses. Yogurt is not necessarily always more viscous than fermented whey beverages. In addition, sensory acceptability was not linked to the product category, pointing to the importance of the individual characteristics. Word association and Cata were able to access the main differences between both products and brought important qualitative and quantitative information regarding consumers' opinions. This study contributed to demystifying the perception that fermented whey beverages have attributes considered inferior, such as lower viscosity and greater syneresis when compared to yogurts. It was found that there is a demand for information about yogurt and fermented whey beverages, which can influence consumers' opinions at the time of purchase.

Keywords: dairy products; sensory parameters; acceptability; consumer science.

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Introduction

Yogurt is one of the oldest fermented dairy products worldwide and it is very popular in a number of countries due to its healthy reputation (Das, Choudhary, & Thompson-Witrick, 2019). Some factors, such as increased per capita spending and urbanization, are likely to fuel yogurt consumption. Increased awareness of its benefits and increased interest in a healthy lifestyle are playing a significant role in this industry. In 2021, the market for yogurt drinks in general was 62.68 billion USD and is predicted to reach 82.58 billion USD in 2028, growing at a rate of approximately 3.6% per year (Yogurt Drinks Market, 2022). In Brazil, yogurts are purchased by 70% of Brazilian families, and in 2021, the sales of yogurt in the country totaled 592 thousand tons, a volume 1.3% greater than that of the previous 12 months (Siqueira, Lana, & Oliveira, 2022).

Yogurt is a fermented milk product produced by decreasing the pH and the coagulation of milk, which must contain at least 70 dairy base and 30% optional non-dairy ingredients. The addition of whey is optional in this product. Another product very similar to yogurt but with some differences are fermented whey beverages. The mandatory ingredients for its manufacture are whey and milk, in a formulation of at least 51 lactic base and 49% of elective ingredients (Brasil, 2005; Brasil, 2007).

Other very important differences between them are the minimum protein percentage and the microorganisms added. Yogurt should contain a minimum of 2.9% protein and specific lactic acid bacteria: *Streptococcus salivarius subsp. thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*. As for the whey beverage, minimum protein is 1.0-1.7% protein in addition to any lactic acid bacteria (Brasil, 2007; Food and Drug Administration [FDA], 2019). In addition to differences in composition, there are also differences perceived by the consumer.

Janiaski, Pimentel, Cruz, and Prudencio (2016) determined that strawberry yogurts and whey beverages are well accepted by consumers, with an overall linking between 4.9-7.2 (9 point scale, where 9 = liked very much). In addition, the authors showed that yogurts were linked with viscosity, acid taste and brightness, while whey beverages were connected with artificial aroma and artificial strawberry taste, already demonstrating a nether perception.

To understand consumers perception, word association is one of the most modern and rapid techniques for sensory analysis. It supports the hypothesis that when an assessor is given a stimulus and asked to freely associate it with what comes to mind, the mental associations are stimulated (Esmerino et al., 2017; Silva et al., 2021; Vieira et al., 2022; Rojas-Rivas, Espinoza-Ortega, Thomé-Ortiz, & Cuffia, 2022). Likewise, the Check-all-that-apply (Cata) method consists of a list of words or phrases from which the assessors are asked to select which ones apply to themselves, or respond to a question about the sample. There is also the possibility of adding non-sensory characteristics to the list, such as consumption habits, hedonic terms, emotions and opposite terms that catch the attention of the judges (Varela & Ares, 2012; Los et al., 2021). Both methodologies have already been used to evaluate yogurts with regards to other parameters (Cruz et al., 2013; Esmerino et al., 2017), not regarding their difference from whey beverages, and possible driving parameters of liking and disliking.

In general, fermented whey beverages are seen by consumers as inferior products to yogurts, especially in terms of texture and viscosity according to Castro et al. (2013) and Janiaski et al. (2016). However, the characteristics of each product are also influenced by factors such as raw material quality, formulations, and manufacturing technology. For these reasons, the consumer perception of both products is quite complex and deserves to be investigated, facilitating the targeting of and selling to this sector.

Thus, the aim of this work was to evaluate consumers' perceptions of the differences between yogurt and fermented whey beverage through the modern sensory techniques of word association and Cata. Moreover, to demonstrate the relationship between physicochemical and sensory responses of these dairy products.

Material and methods

Samples

Samples of three brands of liquid or stirred yogurt (YA, YB and YC) and fermented whey beverage (WA, WB and WC), strawberry flavor, were purchased at a local supermarket. The brands were randomly selected and the products of each brand were from the same lot and within the same expiration date range.

Physicochemical analysis

Some chemical and physical parameters (pH, acidity, total solids, color and texture) were shown to aid in the interpretation of sensory analysis results and in differentiating between the samples. Hydrogen ion potential (pH) was measured by microprocessor bench-top pH meter TEC-5 (Tecnal©, Piracicaba, Brazil). The acidity of the samples was evaluated by titration method using an alkaline sodium hydroxide solution (0.1 M, Synth, SP, Brazil). The result was expressed in g.100 g^{-1} of lactic acid. The gravimetric method determined the total solids at 102°C, in an oven (Deleo©, Porto Alegre, Brazil). Total solids were obtained by calculation, subtracting 100 by the percentage of moisture and volatiles (Association of Official Agricultural Chemists [AOAC], 2005). All these analyses were performed in triplicate.

The L * (lightness), a * (red - green component) and b * (yellow - blue component) color parameters of yogurt and whey beverages were determined using a colorimeter Minolta Chroma Meter CR-400 (Konica Minolta©, Japan). The equipment was calibrated with the ceramic white standard of the equipment. Six measurements were taken for each sample at 4 ± 1°C.

The instrumental texture of yogurts and whey beverages was determined using a texturometer TA.XT Plus (Stable Micro Systems©, Godalming, UK). Texture parameters such as firmness, consistency, cohesiveness and viscosity index were evaluated by the compression test using the 35 mm diameter A/BE probe. Aliquots of the samples (100 mL) were homogenized and inserted into the acrylic test cup until ¾ of its volume was filled. The test velocity was 1 $mm.s^{-1}$ and distance of 30 mm. Eight replicates were tested.

Syneresis

The syneresis was determined by four methods: centrifuge (Karnopp, Oliveira, Andrade, Postingher, & Granato, 2017), filter (Basiri, Haidary, Shekarforoush, & Niakousari, 2018) – with modifications, stainless screen

(Castro et al., 2009) – with modifications, and spontaneous (Tribst, Ribeiro, Leite Junior, Oliveira, & Cristianini, 2018) – also with modifications. The percentage of syneresis (% S) was calculated according to Equation 1.

$$\%S = \frac{Separatedwheymass}{Totalsamplemass} x100 (1)$$

The conditions used were:
a) Centrifuge (Hermle©, Wehingen, DE): In 15 mL conical tubes 10 g of each sample were added in triplicate. The samples were centrifuged at 7870 g for 10 min. at 4°C. The supernatant whey was collected and weighed.
b) Filter: 25 g of sample was weighed on filter paper arranged in a funnel. The whey was collected in a beaker after one hour of drainage under refrigeration. The analysis was performed in triplicate.
c) Stainless screen: First, the drainage of 100 g of sample, in duplicate, in a stainless steel sieve (100 or 200-mesh) coupled to a collection flask. The whey was collected after two hours of drainage under refrigeration.
d) Spontaneous: 50 g of sample in a beaker was weighed in triplicate, at an angle of 45°, and kept in this position under refrigeration. The separated whey was carefully collected and weighed.

Sensory evaluation

The tests were performed at the sensory analysis laboratory of the *Universidade Tecnológica Federal do Paraná* (UTFPR), Francisco Beltrão campus, with 100 untrained assessors. The consumers consisted of 62 men and 38 women, aged between 18 and 50 years old. Prior to the test, participants read and signed an informed consent form. The research was approved by the Research Ethics Committee Involving Human Beings of UTFPR, n° 3.772.592 (CAAE: 17946819.8.0000.5547).

To assess the acceptability of yogurt and fermented whey beverages, the samples were served at 5°C, monadically, in three-digit coded disposable cups (50 mL) in random order. A glass of water was offered to clean the palate between samples. The assessors were informed that they were receiving 'fermented dairy products' so as not to influence their responses and subsequent tests. A structured 9-point hedonic scale was used (1 - I did not like it much; 9 - I liked it very much) and the attributes color, flavor, texture/viscosity and overall acceptability were evaluated (Dutcosky, 2013).

To assess the consumers' perception of yogurt, fermented whey beverages, and their differences, word association and Cata techniques were applied. In the word associations, two stimuli were applied. One group of participants received the stimulus A: 'Please write the first 4 words and/or expressions that come to mind when you read the word: yogurt'. Another group received stimulus B: 'Please write the first 4 words and/or expressions that come to mind when you read the words: Whey beverages'. To avoid possible errors caused by previous contact with the technique, the stimuli were presented to different groups of consumers. All associations provided by the assessors were analyzed, grouped and included in the results (Latorres, Mitterer-Daltoé, & Queiroz, 2016; Marques, Reis, Moura, Bonadimann, & Mitterer-Daltoé, 2018).

For Cata, the assessors were instructed to check the phrases they considered to be true for them regarding the products, according to their perception. In order to evaluate their knowledge about the products, five phrases were used with their opposites (Ares et al., 2015). The advisor who marked the sentence and its opposite was removed from the results compilation, due to lack of apparent attention.

Statistics

The analysis of the word association data was based on Antmann et al. (2011). Associations were grouped into different categories, and these were grouped into different dimensions. Two researchers from the team performed the grouping independently. The final categories and their names were determined by consensus of the sensory team, after considering the independent classifications. Those categories that were mentioned by more than 10% of the participants were included in the statistics. All words were grouped in 9 main categories with 24 specific categories. T Test for < 30 samples and Z Test for > 30 samples highlighted the differences between stimuli (alfa < 0.05).

Cata data analysis used also the T Test and Z Test to point out if mentions of the opposite phrase pairs had any statistical differences (n = 5 pairs). A multivariate correspondence analysis (CA), which is a graphical tool that explores the association of symmetrical structure between variable categories (Beh, Lombardo, & Simonetti, 2011), was performed to evaluate the relationship between stimuli, age and gender of the assessors. Being stimuli (yogurt and whey beverage), gender (F = female; M = male) and age groups (G1 = 18-20 years; G2 = 21-30 years; G3 = 31-40 years and G4 = 41-50 years).

Shapiro-Wilk and Barlett tests evaluated the hypotheses of normality and homoscedasticity of all the data. The physicochemical analysis and sensory acceptability data were submitted to ANOVA and Tukey test or to the nonparametric Kruskal-Wallis test, with a significance level of 5%. Results were expressed as mean ± standard deviation. All tests, graphs and multivariate analyses were performed by Statistica software 12.7 (Statsoft® Inc., Tulsa, OK, EUA) moreover the Hierarchical Cluster Analysis by Past® 3.26.

Results and discussion

Physicochemical analysis

Table 1 presents the results of the physicochemical analyses of commercial yogurts and fermented whey beverages. In general, there was no difference between the categories of yogurts and fermented whey beverages in relation to acidity, pH and total solids.

Some authors claimed that yogurts have a higher total solids content than whey beverages (Castro et al., 2013; Souza et al., 2019), although this fact was not observed in the present work. In addition, there was plenty of variation within the same product category, such as samples YB and YC. One factor that deserves to be highlighted is the YB sample, which is classified as yogurt, but statistically has a physicochemical similarity with whey beverages and not to the other two yogurt samples. The WC sample showed the most intense 'pink color' (Figure 1), which was corroborated by the low luminosity and high a* value.

Table 1. Physicochemical analysis of commercial yogurts (Y) and fermented whey beverages (W).

	Samples					
	YA	YB	YC	WA	WB	WC
Acidity[a] (g 100 g^{-1})	$0.59^{ab} \pm 0.01$	$0.71^{ab} \pm 0.00$	$0.94^{a} \pm 0.06$	$0.70^{ab} \pm 0.01$	$0.52^{b} \pm 0.00$	$0.59^{ab} \pm 0.00$
pH	$4.33^{a} \pm 0.03$	$4.01^{b} \pm 0.07$	$4.10^{ab} \pm 0.05$	$4.18^{ab} \pm 0.07$	$4.10^{ab} \pm 0.02$	$4.10^{ab} \pm 0.06$
TS (g 100 g^{-1})	$17.45^{ab} \pm 0.07$	$15.91^{b} \pm 0.39$	$21.10^{a} \pm 0.12$	$19.68^{ab} \pm 0.07$	$18.65^{ab} \pm 0.05$	$18.35^{ab} \pm 0.09$
L*	$83.64^{a} \pm 0.93$	$80.54^{ab} \pm 0.55$	$78.69^{bc} \pm 0.60$	$80.26^{abc} \pm 0.81$	$79.25^{abc} \pm 0.36$	$63.09^{c} \pm 0.87$
a*	$16.36^{ab} \pm 0.20$	$16.53^{ab} \pm 0.32$	$19.50^{a} \pm 0.10$	$13.86^{b} \pm 0.27$	$9.18^{b} \pm 0.19$	$23.48^{a} \pm 0.56$
b*	$0.60^{c} \pm 0.22$	$2.91^{ab} \pm 0.08$	$5.80^{a} \pm 0.24$	$2.33^{bc} \pm 0.12$	$2.28^{bc} \pm 0.16$	$3.89^{ab} \pm 0.20$
F (N)	$0.190^{ac} \pm 0.011$	$0.112^{b} \pm 0.004$	$0.221^{a} \pm 0.013$	$0.118^{b} \pm 0.004$	$0.130^{ab} \pm 0.002$	$0.129^{bc} \pm 0.003$
C (N s)	$4.815^{b} \pm 0.255$	$4.128^{c} \pm 0.277$	$5.512^{a} \pm 0.331$	$4.147^{c} \pm 0.298$	$4.297^{c} \pm 0.131$	$4.138^{c} \pm 0.047$
CH (N)	$-0.112^{bc} \pm 0.006$	$-0.071^{a} \pm 0.007$	$-0.134^{c} \pm 0.019$	$-0.075^{a} \pm 0.002$	$-0.082^{ab} \pm 0.003$	$-0.085^{abc} \pm 0.002$
VI (N s)	$-0.645^{bc} \pm 0.210$	$-0.142^{a} \pm 0.043$	$-1.357^{b} \pm 0.267$	$-0.056^{a} \pm 0.256$	$-0.200^{ac} \pm 0.020$	$-0.223^{abc} \pm 0.018$
	Syneresis (%)					
Centrifuge	$48.01^{a} \pm 1.13$	$56.69^{a} \pm 0.43$	$38.77^{b} \pm 0.34$	$58.80^{a} \pm 2.50$	$58.10^{a} \pm 1.85$	$55.83^{a} \pm 0.30$
Filter	$37.85^{c} \pm 1.70$	$46.37^{b} \pm 3.01$	$22.99^{d} \pm 1.05$	$52.05^{a} \pm 1.48$	$40.81^{c} \pm 1.37$	$4.91^{e} \pm 0.39$
Stainless screen	4.05 ± 0.60	39.24 ± 0.45	4.43 ± 1.73	7.51 ± 4.61	3.53 ± 0.75	ND
Spontaneous	ND	14.28 ± 1.85	ND	0.90 ± 0.14	ND	ND

Results expressed as mean ± standard deviation. Different letters in the same line indicated significant differences between samples at $p < 0.05$ level. [a]lactic acid. TS = total solids. F = Firmness; C = Consistency; CH = Cohesiveness; VI = Viscosity Index. ND = not determined.

Figure 1. Color of commercial yogurts (YA, YB and YC) and fermented whey beverage (WA, WB, WC).

Regarding texture parameters, it was noted that some samples of whey beverages were similar to the yogurt samples, with no significant difference between the categories in the different texture parameters (Table 1). When analyzing the parameters of the YB sample, it was possible to observe parameters closer to whey beverages and not to the other yogurt samples analyzed. This demonstrated a lack of standards for different brands of the same product category.

The YC and YA samples showed higher consistency. The YC sample with the highest values for texture parameters, in general, was the one that had the highest total solids content. The solids content interferes with the texture of fermented dairy products, but other factors also influence it, such as the degree of gel breakage after fermentation (Mitra, Nepal, & Tavade, 2022). The addition of whey is usually associated with reduced viscosity in whey beverages when compared to yogurt. However, this is not always observed, as the use of thickeners and manufacturing technology influence the viscosity of these products.

Table 1 displays the results of the syneresis of yogurts and commercial whey beverages by different methods. It was possible to obtain the serum separation for all samples analyzed using the centrifuge method, with total separation of the liquid from the solid phase. It was possible to state that the YC sample presented the lowest serum separation, differing from all other samples in syneresis (%), by this method. According to Tribst et al. (2018), the high g-force to which the samples are subjected may be sufficient to induce a similar break in the protein network of different samples.

As for the filter method, samples WA and YB revealed high serum separation. For the WC sample, there was little serum separation, diverging from the other samples. Analyzing its composition (the label), it was noted that this sample had the addition of cassava starch, which may have contributed to the lower separation of serum by this method. The use of cassava starch contributed to a high water retention capacity and lower syneresis (Imbachí-Narváez, Sepúlveda-Valencia, & Rodríguez-Sandoval, 2019).

In the determination of syneresis by stainless screen, due to the different viscosities of the dairy products, for the samples YA and YC (high viscosity) a 100-mesh sieve was used, because in the 200-mesh sieve there was no separation of the serum in YA and YC. For the YB, WA and WB samples, a 200-mesh sieve was used because the 100-mesh sieve has larger pores and the samples passed through, thus not separating the phases in this sieve. The WC sample was tested with 100 and 200-mesh sieves and in both there was no phase separation for the syneresis determination. For this method, the YB sample showed the highest syneresis (%).

The spontaneous syneresis method was only possible for YB and WA samples. For the other samples, there was no serum separation by this method. Although the WA sample showed a high syneresis in the centrifuge and stainless steel methods, this was not registered by the spontaneous syneresis method.

As Amatayakul, Sherkat, and Shah (2006) stated, the different syneresis methods evaluate different data, for this reason it can be inferred that the results for each brand are not similar between the methods. The centrifuge method measures the level of serum expulsion from the gels when subjected to collapse with the application of force, which in this case is centrifugal force. In addition, it evaluates the water retention capacity of the product. The filter and stainless steel methods determine the amount of serum that is expelled from the yogurt gel under the influence of gravity, differentiating them only by pore size. Spontaneous method aims to measure the amount of serum that is spontaneously separated on the gel surface and is the method that most closely matches the 'real syneresis' in yogurts.

The syneresis of the product is influenced by its formulation, since the expulsion of the liquid phase of the gel depends on the type of molecules grouped there and on the amount of total solids (carbohydrates, proteins and lipids). Another very significant factor is the type of starter culture used, due to the acidity rate produced and the production capacity of exopolysaccharides. In addition, the intensity of gel breakage after fermentation also interferes with the syneresis of the products (Das et al., 2019; Gilbert, Rioux, St-Gelais, & Turgeon, 2020). Analyzing all definitions of syneresis, it can be suggested that it is an important parameter also within the sensory evaluation, as it is directly linked to the product's solids and its texture.

Analyzing the physicochemical data by PCA (Figure 2), there was an 87.25% explanation in the first two factors, with 100% completion in the third factor, representing the data well. The pH that received the highest coefficient score (0.85) was linked to factor 2. The WA and YC samples showed a positive correlation, while YC and YB exhibited a negative correlation. This multivariate result demonstrated the dissimilarity of the samples, as it did not separate yogurt from whey beverages, as expected, making their sensory responses even more complex.

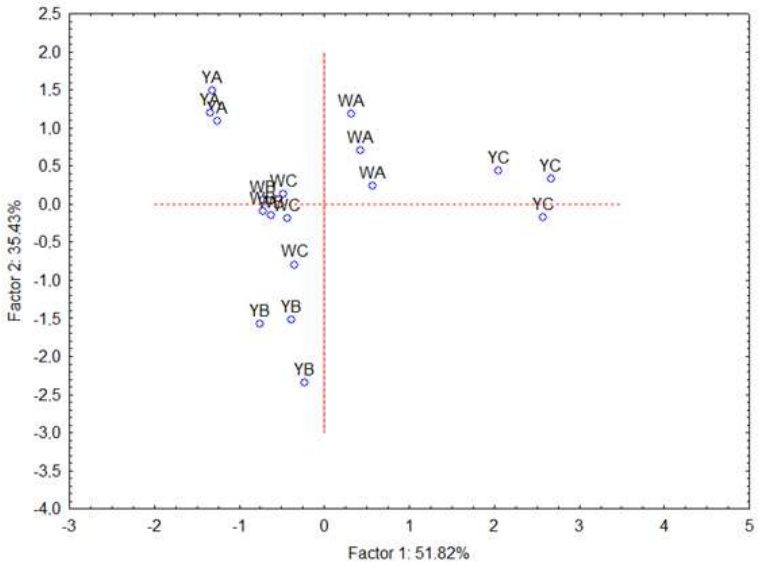

Figure 2. PCA of the physicochemical data, in addition to the color, texture and syneresis of the samples of yogurts (YA, YB, YC) and fermented whey beverages (WA, WB, WC).The sum of the first two factors F1 + F2 = 87.25%.

Sensory acceptability

The YC sample stood out from the others with the highest value of sensory acceptability (Table 2). This sample also showed the highest values in the analysis of instrumental texture. The lowest values for acceptability were for samples YB and WA, which had lower viscosity indices and less firmness (Table 1). Thus, it can be seen that the assessors had better acceptance of more viscous dairy products. The textural attributes are the most important factors in the quality and overall consumer sensory acceptance of yogurts (Mitra et al., 2022; Vieira et al., 2022). In addition, the results demonstrated that sensory acceptability is not associated with the product category, meaning that consumers choose individual characteristics of each product not the category, whether it is a yogurt or a whey beverage.

Table 2. Sensory acceptability of commercial yogurts (Y) and fermented whey beverage (W).

Sample	Color	Flavor	Texture	Overall acceptability
YA	$6.87^{b} \pm 1.52$	$6.88^{ab} \pm 1.95$	$6.95^{ab} \pm 1.70$	$6.91^{b} \pm 1.61$
YB	$6.43^{bc} \pm 1.73$	$5.15^{c} \pm 2.25$	$5.29^{d} \pm 2.04$	$5.38^{c} \pm 2.13$
YC	$7.54^{a} \pm 1.29$	$7.57^{a} \pm 1.67$	$7.47^{a} \pm 1.47$	$7.64^{a} \pm 1.23$
WA	$6.58^{b} \pm 1.69$	$6.29^{b} \pm 2.13$	$5.97^{cd} \pm 2.05$	$6.25^{bc} \pm 1.84$
WB	$5.49^{c} \pm 2.12$	$6.47^{b} \pm 2.05$	$6.37^{bc} \pm 1.93$	$6.38^{b} \pm 1.86$
WC	$6.26^{b} \pm 2.20$	$6.43^{b} \pm 1.93$	$6.48^{bc} \pm 1.89$	$6.41^{b} \pm 1.75$

Results expressed as mean ± standard deviation. Different letters in the same column indicated significant differences between samples, by Kruskal-Wallis, at $p < 0.05$ level.

The hierarchical cluster analysis (HCA) (Figure 3) confirmed the separation between YC and YB, corroborated by the results of the physicochemical analysis (Figure 2) and acceptability (Table 2). WA and WC showed similarities in the sensory parameters, with the shortest Euclidean distance in the sensory analysis and a cophenetic coefficient of 0.73 (which confirmed the quality of the cluster). The HCA exposed a distance between YB and WA, confirming that the evaluation of sensory parameters was carried out independently of the overall acceptability, which means the preference of each assessor did not affect the evaluation of the color, flavor and texture parameters. YB remained isolated, as it presented the highest values for all parameters.

Word association

The terms raised by the assessors were grouped into categories and subcategories. More than 50 terms were considered for statistical and correspondence analysis. The p-value (Table 3) indicated whether there is a significant difference between the number of mentions of the yogurt and whey beverage stimuli.

The subcategory *Lactobacillus/microorganisms* was linked significantly more often to the whey beverage stimulus, while the subcategories 'yogurt, whey, practicity' and 'fermented milk' were only mentioned in this stimulus. This result indicates that the whey beverage is instinctively connected to yogurt and 'fermented

milk'. In addition, it indicated that 'whey' was connected to the formulation of the whey beverage and even with a single mention, 'practicity' was connected to the whey beverage and not to the yogurt. This may have occurred because the yogurt is presented in different consistencies, and some require the use of utensils to ingest it. The whey beverage does not refer to this inconvenience.

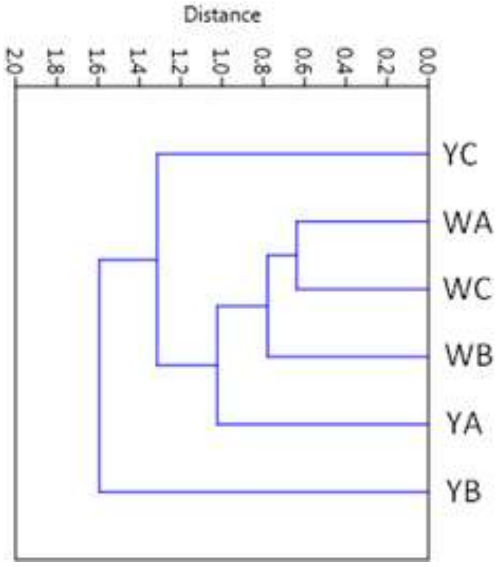

Figure 3. Hierarchical cluster analysis (HCA) of sensory data. Euclidean distance among samples of yogurts (YA, YB, YC) and fermented whey beverages (WA, WB, WC).

Table 3. Terminology raised in the word association and difference between stimuli, yogurt and fermented whey beverage.

Categories and subcategories	Yogurt	Whey beverage	p-value
Trade mark			
Danone, Greek, Nescau, Chocomilk, Yakult	5	9	0.14
Manufacturing			
Lactobacillus/Microorganisms	2	10	< 0.01
Fermentation	10	14	0.26
Composition			
Lactose/Sugar/Casein	3	6	0.17
Milk/Milk derivative	24	32	0.13
Whey	0	4	--
Hedonic			
Cold/Temperature	3	2	0.57
Tasty/Yummy/Good/Delicious	17	8	0.01
Sensory Attribute			
Texture: Viscous/Thick/Dense	20	11	0.02
Pink color	15	3	< 0.01
Sweet	16	2	< 0.01
Acid	7	1	< 0.01
Meal			
Breakfast/Snack/Dessert	6	5	0.68
Health			
Nutritious/healthy	6	6	1.00
Food/Flavors			
Flavors: Strawberry/Coconut/Fruits	33	8	< 0.01
Foods: Cheese/Cereal/Cornflakes/Coffee/Vitamin/Ice cream	8	4	0.11
Yogurt	0	22	--
Beverage	4	3	0.62
Whey beverage	1	0	--
Fermented milk	0	7	--
Behaviour			
Nostalgia/childhood/Remember/Child	7	5	0.43
Market/tray	1	2	0.51
Practicity	0	1	--

T Test for < 30 samples, Z Test for > 30 samples. Alfa = 0.05 for both.

With a significant number of mentions, yogurt stood out in the category of hedonic terms (tasty/yummy/good/delicious) and sensory attributes, such as texture (viscous/thick/dense), color, sweetness and acidity. The 'pink color' mentioned 15 times for the yogurt stimulus is related to the 'strawberry' flavor, which is one of the most traditional flavors. It was noted that in the subcategory 'flavors' of the yogurt stimulus, there were 33 mentions for 'strawberry' and other 'fruits', with a significant difference for the 8 mentions of the other stimuli.

Another result that should be highlighted is the connection of both stimuli with famous commercial brands, Nescau, Chocomilk and Yakult appearing only for the whey beverage, Danone for both whey beverage and yogurt, and Greek only for the yogurt stimulus. In addition, in the behavior category, it was noted that both stimuli referred to 'childhood/child'. Additionally, both were associated to the 'daily meals' where this type of product is consumed, and in the 'health' category, as they were considered 'nutritious' and 'healthy'.

It is important to explore and analyze the general perception of consumers about food products with their own vocabulary. The word association allows access to this sort of response, which can assist in the development and improvement of these kinds of products. The fact that the nostalgic terms raised, no negative responses only reinforces the positive contact of consumers with both products.

Some of the results discussed are corroborated by CA (Figure 4), with 84% explanation in the first two dimensions, such as the positive correlation among the yogurt stimulus (0.99), with the 'texture' (0.82), 'hedonic' (0.78) and 'pink color' (0.97) terms, which presented high quality values. This quality value demonstrates the strength of the variable in the correlation proposed by CA, with closer to 1.0 being better. The stimulus whey beverage (0.99) was shown to be positively 'associated with whey' (0.79), 'yogurt' (0.99) and 'trade marks' (0.85).

The female gender variable (F), along with age group 2 (G2), from 21-30 years old, showed a positive correlation with the terms of behavior, 'nostalgia/childhood' (0.65), 'flavors/strawberry' (0.94) and health (0.93). This indicates greater concern by women for healthy products. While G1 (18-20 years old) and M (male) showed affinity for the subcategories 'milk/derivative' (0.91), 'fermented milk' (0.97) and 'market/tray' (0.88).

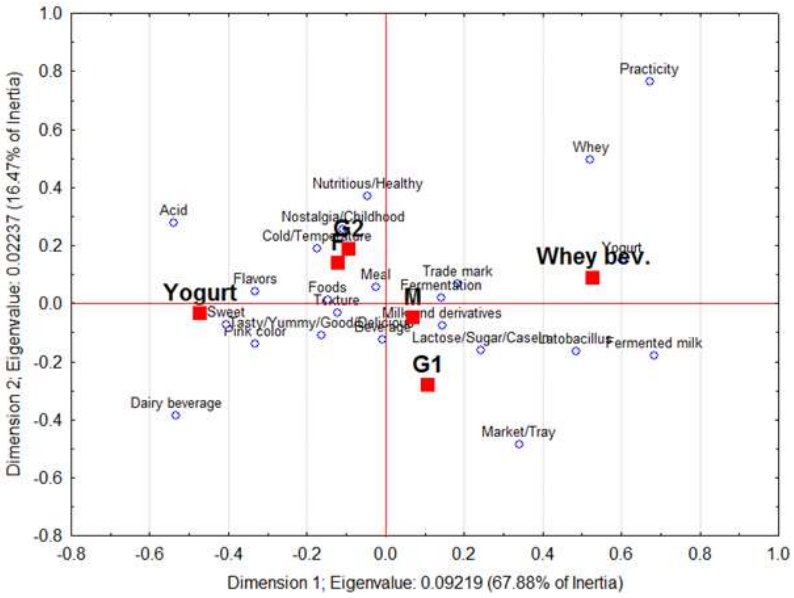

Figure 4. Correspondence Analysis (CA) of the subgroups raised in the word association and the divisions between gender (F = female; M = male), age groups (G1 = 18-20 years; G2 = 21-30 years) and stimuli (yogurt and fermented whey beverage [Whey bev.]).

Cata

Of the 100 assessors who participated in the sensory analysis, 23 were eliminated in the Cata for providing duplicate responses, meaning they checked a sentence and its corresponding opposite. The Z test applied to the sentence pairs resulted in a significant difference for the five pairs, which indicated that one of the sentences in the pair was considered more correct than the other (Table 4). All Z values found were greater than the critical.

The data displayed considerable knowledge by the assessors of the yogurt and whey beverage products. From 77 assessors, 54 pointed out that there is a difference between the production of both, 48 considered

that the use of whey makes products more nutritious, 45 noted that yogurt and whey beverages have different compositions and 43 that whey can also be added in yogurts.

Conversely, 56 assessors stated they considered yogurt always more viscous than whey beverage. This statement is not always true, which was confirmed by the texture analysis, since one of the 'yogurts' (YB) presented a viscosity, firmness and consistency values similar to the parameters of whey beverages (Table 1). In addition, this sample of yogurt had a visually more liquid consistency than the evaluated beverages, also receiving a lower value for the texture attribute (Table 2) in the sensory evaluation.

CA investigated the variables (M; F; G) and phrases (P1-P10), linking them to 75% of descriptions in the first two dimensions (Figure 5). Of the variables, gender was more significant, M (quality value: 0.98), F (0.97) followed by age group 1 G1 (18-20 years) with a quality value of 0.76.

CA explored the phrases, where P4, P5, P7, P8, P9 and P10 presented the highest quality values (0.85, 0.81, 0.95, 0.72, 0.96 and 0.86 respectively). Considering P4, positively correlated with P10, as both mention the differences between yogurt and whey beverage in production and composition, thus confirming consumers' knowledge of the existence of differences, without attributing negative perceptions to any of the products. Both are also close to G1, due to the greater number of assessors in this group.

Table 4. Z test to check the difference between the phrases verified by the Cata methodology

Cata Phrase	Name	M	F	G1	G2	G3	G4	Z
Only in whey beverages the whey addition is permitted	P1	5	4	4	4	1	0	9.10
Yogurt can also be made with whey	P2	25	18	20	22	1	0	
The composition of yogurt is the same as the whey beverage	P3	12	4	6	10	0	0	6.81
Yogurt has a different composition of the whey beverage	P4	23	22	21	21	1	1	
The use of whey makes products more nutritious	P5	33	15	19	25	2	1	9.55
The use of whey makes products less nutritious	P6	5	3	4	4	0	0	
The whey beverage can be more viscous than yogurt	P7	1	6	2	5	0	0	10.30
Yogurt is always more viscous than whey beverage	P8	36	20	28	24	2	1	
There is no difference in the production process of whey beverage and yogurt	P9	5	3	2	5	1	0	10.21
There is a difference in the production of whey beverage and yogurt	P10	31	23	28	22	1	1	

Z critical = 1.96 (alfa = 0.05). All phrases differed significantly from the corresponding opposites. M (male); F (female); G1 (18-20 years old); G2 (21-30 years old); G3 (31-40 years old) and G4 (41-50 years old).

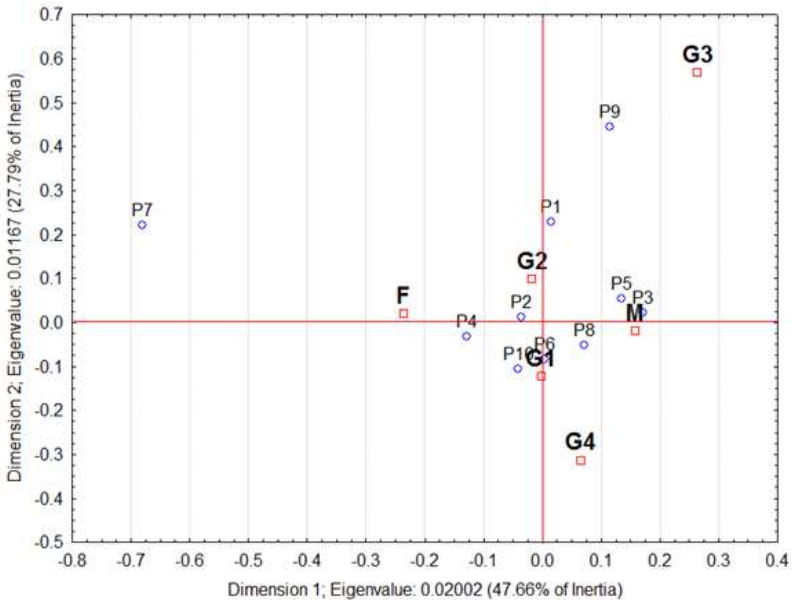

Figure 5. Correspondence Analysis of Cata phrases compared to the number of assessors who marked the phrase, divided into gender (F = female; M = male) and age groups (G1 = 18-20 years; G2 = 21-30 years; G3 = 31-40 years and G4 = 41-50 years).

As for P8, the answer that prevailed over yogurt was 'always more viscous than whey beverage', which was positively correlated with the male gender, indicating the preference by men for yogurt. This perception is not correct, as yogurt can be less viscous than whey beverage. Thus, there is a need for greater clarity and disclosure of this information by food brands, moreover via professionals and food industries.

P7, although distant from the other variables, was positively correlated with the female gender, indicating that women checked this phrase more often than men and that they believe that 'whey beverage can be more viscous than yogurt'. This fact further demonstrated a variability in viscosity between yogurts and whey beverages of different brands, which did not generate homogeneous responses from the assessors; there was no consensus between genders.

Understanding the evaluation of sensory characteristics of dairy product is of utmost importance to all dairy producers, processors, markets and consumers. The quality of finished products is not achieved by chance, but is the result of the skilled execution of a standard process. Thus, a high level of sensory studies like the present one is determinant in evaluating the quality of dairy products, helping and guiding the industry to improved products.

Conclusion

This study revealed that there are differences between yogurts and fermented whey beverages regarding the physicochemical parameters, without separating the samples into two large groups or categories. The texture varied among yogurts, while whey beverages had similar characteristics. The texture of the products is the physicochemical parameter that most influenced consumers' evaluation and not the fact that it is a yogurt or whey beverage.

Thus, this study contributed to the demystification that whey beverages have attributes considered inferior, such as lower consistency, viscosity and greater syneresis when compared to yogurts. These attributes are not always observed, as the characteristics are inherent to each product, and there is no homogeneity within each category.

In addition, the sensory techniques of word association and Cata proved to be highly effective in assessing consumers' knowledge about yogurt, fermented whey beverages and their differences. Both raised a unique, diversified terminology, with informal and easy to understand words, which reinforces the importance of this study for researchers, developers and the dairy industry. Finally, there was also note the need to disseminate information regarding the yogurt attributes, as it is not necessarily always more viscous than whey beverages, as is not a rule, which can influence the opinion of consumers at the time of purchase.

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References

Amatayakul, T., Sherkat, F., & Shah, N. P. (2006). Syneresis in set yogurt as affected by EPS starter cultures and levels of solids. *International Journal of Dairy Technology, 59*(3), 216-221. DOI: https://doi.org/10.1111/j.1471-0307.2006.00264.x

Antmann, G., Ares, G., Varela, P., Salvador, A., Coste, B., & Fiszman, S. M. (2011). Consumers' texture vocabulary: Results from a free listing study in three Spanish-speaking countries. *Food Quality and Preference, 22*(1), 165-172. DOI: https://doi.org/10.1016/j.foodqual.2010.09.007

Ares, G., Jaeger, S. R., Antúnez, L., Vidal, L., Giménez, A., Coste, B., ... Castura, J. C. (2015). Comparison of TCata and TDS for dynamic sensory characterization of food products. *Food Research International, 78*, 148-158. DOI: https://doi.org/10.1016/j.foodres.2015.10.023

Association of Official Agricultural Chemists [AOAC]. (2005). *Official methods of analysis* (18th ed.). Washington, DC: AOAC.

Basiri, S., Haidary, N., Shekarforoush, S. S., & Niakousari, M. (2018). Flaxseed mucilage: a natural stabilizer in stirred yogurt. *Carbohydrate Polymers, 187*, 59-65. DOI: https://doi.org/10.1016/j.carbpol.2018.01.049

Beh, E. J., Lombardo, R., & Simonetti, B. (2011). A European perception of food using two methods of correspondence analysis. *Food Quality and Preference, 22*(2), 226-231. DOI: https://doi.org/10.1016/j.foodqual.2010.10.001

Brasil. (2005). *Instrução normativa no. 16, de 23 de agosto de 2005. Aprova o regulamento técnico de identidade e qualidade de bebida láctea.* Brasília, DF: Diário Oficial da União.

Brasil. (2007). *Instrução normativa no. 46, de 23 de outubro de 2007. Aprova o regulamento técnico de identidade e qualidade de leites fermentados.* Brasília, DF: Diário Oficial da União.

Castro, F. P., Cunha, T. M., Ogliari, P. J., Teófilo, R. F., Ferreira, M. M. C., & Prudêncio, E. S. (2009). Influence of different content of cheese whey and oligofructose on the properties of fermented lactic beverages: study using response surface methodology. *LWT - Food Science and Technology, 42*(5), 993-997. DOI: https://doi.org/10.1016/j.lwt.2008.12.010

Castro, W. F., Cruz, A. G., Bisinotto, M. S., Guerreiro, L. M. R., Faria, J. A. F., Bolini, H. M. A., ... Deliza, R. (2013). Development of probiotic dairy beverages: Rheological properties and application of mathematical models in sensory evaluation. *Journal of Dairy Science, 96*(1), 16-25. DOI: https://doi.org/10.3168/jds.2012-5590

Cruz, A. G., Cadena, R. S., Castro, W. F., Esmerino, E. A., Rodrigues, J. B., Gaze, L., ... Bolini, H. M. A. (2013). Consumer perception of probiotic yogurt: performance of check all that apply (CATA), projective mapping, sorting and intensity scale. *Food Research International, 54*(1), 601-610. DOI: https://doi.org/10.1016/j.foodres.2013.07.056

Das, K., Choudhary, R., & Thompson-Witrick, K. A. (2019). Effects of new technology on the current manufacturing process of yogurt-to increase the overall marketability of yogurt. *LWT - Food Science and Technology, 108*, 69-80. DOI: https://doi.org/10.1016/j.lwt.2019.03.058

Dutcosky, S. D. (2013). *Análise sensorial de alimentos* (4. ed., rev. e ampl.). Curitiba, PR: PUCpress.

Esmerino, E. A., Ferraz, J. P., Tavares Filho, E. R., Pinto, L. P. F., Freitas, M. Q., Cruz, A. G., & Bolini, H. M. A. (2017). Consumers' perceptions toward 3 different fermented dairy products: Insights from focus groups, word association, and projective mapping. *Journal of Dairy Science*, *100*(11), 8849-8860. DOI: https://doi.org/10.3168/jds.2016-12533

Food and Drug Administration [FDA]. (2019). *Title 21- food and drugs, Chapter i- Food and drug administration, department of health and human services, Subchapter b - Food for human consumption, Part 131- Milk and cream. Subpart b - Requirements for specific standardized milk and cream. Sec. 131.200 yogurt.* Department of health and Human Services. Retrieved from https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=131

Gilbert, A., Rioux, L.-E., St-Gelais, D., & Turgeon, S. L. (2020). Studying stirred yogurt microstructure using optical microscopy: how smoothing temperature and storage time affect microgel size related to syneresis. *Journal of Dairy Science, 103*(3), 2139-2152. DOI: https://doi.org/10.3168/jds.2019-16787

Imbachí-Narváez, P. C., Sepúlveda-Valencia, J. U., & Rodríguez-Sandoval, E. (2019). Effect of modified cassava starch on the rheological and quality properties of a dairy beverage prepared with sweet whey. *Food Science and Technology, 39*(1), 134-142. DOI: https://doi.org/10.1590/1678-457X.28017

Janiaski, D. R., Pimentel, T. C., Cruz, A. G., & Prudencio, S. H. (2016). Strawberry-flavored yogurts and whey beverages: what is the sensory profile of the ideal product? *Journal of Dairy Science, 99*(7), 5273-5283. DOI: https://doi.org/10.3168/jds.2015-10097

Karnopp, A. R., Oliveira, K. G., Andrade, E. F., Postingher, B. M., & Granato, D. (2017). Optimization of an organic yogurt based on sensorial, nutritional, and functional perspectives. *Food Chemistry, 233*, 401-411. DOI: https://doi.org/10.1016/j.foodchem.2017.04.112

Latorres, J. M., Mitterer-Daltoé, M. L., & Queiroz, M. I. (2016). Hedonic and Word Association Techniques confirm a successful way of introducing Fish into public school meals. *Journal of Sensory Studies, 31*(3), 206-212. DOI: https://doi.org/10.1111/joss.12204

Los, P. R., Simões, D. R. S., Benvenutti, L., Zielinski, A. A. F., Alberti, A., & Nogueira, A. (2021). Combining chemical analysis, sensory profile, CATA, preference mapping and chemometrics to establish the consumer quality standard of Camembert-type cheeses. *International Journal of Dairy Technology, 74(2),* 371-382. DOI: https://doi.org/10.1111/1471-0307.12753

Marques, C., Reis, A., Moura, C., Bonadimann, F. S., & Mitterer-Daltoé, M. L. (2018). Consumer insight into the monosodium glutamate. *Acta Scientiarum. Technology, 40*(1), e30838. DOI: https://doi.org/10.4025/actascitechnol.v40i1.30838

Mitra, P., Nepal, K., & Tavade, P. (2022). Effect of whey and soy proteins fortification on the textural and rheological properties of value-added yogurts. *Applied Food Research, 2*(2), 100195. DOI: https://doi.org/10.1016/j.afres.2022.100195

Rojas-Rivas, E., Espinoza-Ortega, A., Thomé-Ortiz, H., & Cuffia, F. (2022). More than words! A narrative review of the use of the projective technique of word association in the studies of food consumer behavior: Methodological and theoretical implications. *Food Research International, 156,* 111124. DOI: https://doi.org/10.1016/j.foodres.2022.111124

Silva, W. P., Pimentel, T. C., Silva, C. B. F., Pagani, M. M., Cruz, A. G., Freitas, M. Q., & Esmerino, E. A. (2021). Story completion technique: a useful methodology to evaluate the risk perception of consumers from different regions of Brazil about cheeses sold at open markets. *Journal of Sensory Studies, 36*(6), e12702. DOI: https://doi.org/10.1111/joss.12702

Siqueira, K. B., Lana, M. S., & Oliveira, T. S. C. (2022). *Um panorama recente do consumo de lácteos no Brasil*. Embrapa. Retrieved from https://encurtador.com.br/rKQV2

Souza, T. S. P., Luna, A. S., Barros, D. B., Pimentel, T. C., Pereira, E. P. R., Guimarães, J. T., ... Cruz, A. G. (2019). Yogurt and whey beverages available in Brazilian market: mineral and trace contents, daily intake and statistical differentiation. *Food Research International, 119*, 709-714. DOI: https://doi.org/10.1016/j.foodres.2018.10.050

Tribst, A. A. L., Ribeiro, L. R., Leite Junior, B. R. C., Oliveira, M. M., & Cristianini, M. (2018). Fermentation profile and characteristics of yoghurt manufactured from frozen sheep milk. *International Dairy Journal, 78*, 36-45. DOI: https://doi.org/10.1016/j.idairyj.2017.10.005

Varela, P., & Ares, G. (2012). Sensory profiling, the blurred line between sensory and consumer science. A review of novel methods for product characterization. *Food Research International, 48*(2), 893-908. DOI: https://doi.org/10.1016/j.foodres.2012.06.037

Vieira, T. C., Pinto, V. R. A., Rocha, F., Pires, A. C. S., Minim, V. P. R., & Vidigal, M. C. T. R. (2022). New insights into perceptions of technology claims in greek-style yogurt: a view in the COVID-19 pandemic. *Food Research International, 161*, 111822. DOI: https://doi.org/10.1016/j.foodres.2022.111822

Yogurt Drinks Market. (2022). *Yogurt drinks market 2022-2028*. Retrieved on September 09, 2022 from https://www.marketwatch.com/press-release/yogurt-drinks-market-size-2022-global-companies-consumption-drivers-top-leading-countries-trends%E2%80%A6