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Perceptual mapping of yogurt sweeteners among Argentine consumers

Mapa perceptual de los edulcorantes de yogur entre los consumidores argentinos

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Abstract

The rise in consumption of dairy products has been accompanied by an increase in the use of sweeteners by companies as a way of expanding customer options. The aim of this article is to examine the perceptions of Argentine consumers regarding the sugar substitutes used in yogurt production. The study used a descriptive methodology based on an incidental sample of 115 university students (61% women) aged 18-25 years (M=20.51, SD=2.121). Participant perceptions and evaluations were defined using Multidimensional Scaling (MDS), Principal Component Analysis (PCA) and correlation

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analysis to establish a perceptual map illustrating the positioning of different sweeteners based on two dimensions: 'Sweetening Power' and 'Aesthetics and Colour'. The study found that the sweeteners used in yogurt production may be visually represented on both of these axes, demonstrating the potential of techniques such as MDS and PCA in studying consumer perceptions as alternatives to other multivariate techniques.

Keywords: multidimensional scaling, principal component analysis, perceptual mapping, yogurt, sweeteners

Resumen

El consumo de derivados lácteos como el yogur se encuentra en aumento y los consumidores buscan nuevas opciones. El auge de los endulzantes alternativos al azúcar representa una oportunidad para las organizaciones. Este artículo tiene como objetivo identificar las percepciones de los consumidores argentinos con respecto a los endulzantes utilizados en la producción de yogures. Para ello, se implementó un diseño descriptivo y se alcanzó una muestra incidental de 115 estudiantes universitarios (Mujeres=61%) entre 18 y 25 años (M=20.51, DE=2.121). Mediante escalamiento multidimensional (MDS, por sus siglas en inglés), análisis de componentes principales (PCA, por sus siglas en inglés) y análisis correlacional se definieron las percepciones y valoraciones de los participantes. A partir de los análisis realizados fue posible establecer un mapa perceptual que da cuenta del posicionamiento de los diferentes endulzantes en base a dos dimensiones: "Poder Endulzante" y "Estética y Color". El estudio concluye que los endulzantes utilizados en la producción de yogures pueden ser representados visualmente en los dos ejes mencionados, evidenciando la capacidad de utilizar técnicas como el MDS y PCA en el estudio de las percepciones de los consumidores, como alternativas a otras técnicas multivariantes.

Palabras clave: escalamiento multidimensional, análisis de componentes principales, mapa perceptual, yogur, endulzantes

1. INTRODUCTION

Dairy products have been part of the human diet for centuries. Since humanity adopted a sedentary lifestyle, it gradually began to develop agriculture and animal domestication. These processes led to the inevitable need to store and therefore preserve these foods (Wacher Rodarte, 2014). Over time and with the development of civilizations, producers identified an opportunity in dairy consumption. Once a way to transport and preserve milk was devised, this market began to take shape and grow, and consumers developed a dependency on it (Valenze, 2011).

In Europe, the spread of milk consumption extended until years after World War II. However, as milk consumption declined, it was supplanted by the consumption of derived products such as cheese, butter, and yogurt (Collantes, 2014). A similar trend occurred in Argentina in recent decades. According to a study conducted by CESNI describing the evolution of Argentinians' food consumption patterns between 1996 and 2013, milk consumption decreased, while yogurt intake increased conversely (Zapata, Rovirosa, and Carmuega, 2016).

Currently, the Argentine dairy sector represents a key component of the national economy, with significant growth in recent years. According to data from Observatorio de la Cadena Láctea Argentina (OCLA), dairy production reached its highest level since 2015 in 2022, producing 11.557 billion liters of milk, representing an increase compared to the previous year (Bolsa de Comercio de Rosario, 2023a). This production increase translated into record exports, contributing to the sector's growth and its rising share in Argentina's Gross Domestic Product (GDP) (INDEC, 2023).

In terms of GDP, the dairy sector has maintained significant participation in the Argentine economy. According to OCLA, in 2022, the dairy sector represented 10% of the national GDP, underscoring its importance in generating added value and employment in the country (Bolsa de Comercio de Rosario, 2023a).

Regarding sales volumes, the dairy sector has experienced steady growth in recent years. Dairy exports hit a record high in 2022, with total sales of US$1.571 billion and 388,043 tons exported (Bolsa de Comercio de Rosario, 2023a). This increase in exports has contributed to the sector's growth and strengthened its position in the international market.

As for employment, the agribusiness sector is a significant job generator in Argentina. According to a study by Bolsa de Comercio de Rosario (2023b), in 2017, the Agro-Food Chains supported by the dairy sector employed 2.1 million people, accounting for 34% of total employment in activities producing goods nationwide.

In terms of dairy product substitution, there is an increasing diversification in dairy products consumed. In 2022, powdered milk accounted for 46% of total exports in the sector, followed by cheese at 25% and butter at 10% (Bolsa de Comercio de Rosario, 2023a). This suggests a trend toward diversifying dairy products, with a growing demand for processed products.

In this context, it is relevant to investigate Argentine consumers' perceptions and evaluations regarding the sweeteners used in yogurt production. The primary aim of this study is to identify the preferences of Argentine consumers regarding the sweeteners used in yogurts.

This research holds significant social and economic importance, as it will provide valuable information for producers and companies in the Argentine dairy sector, enabling them to tailor their products to meet consumer preferences and needs.

2. THEORETICAL FRAMEWORK

This study focuses on consumer perceptions regarding sweeteners. However, given the use of an innovative methodology based on an extensive theoretical analysis, it has been deemed appropriate to include a detailed justification of the methods employed. To achieve greater clarity, the theoretical framework has been divided into two main sections.

The first section of the theoretical framework, "yogurt consumption," examines the various perceptions consumers may have regarding yogurt and sweeteners, including their preferences, aversions, and perceptions of the benefits and risks associated with their consumption.

The second section of the theoretical framework, "perceptual maps," focuses on the analysis methodology used in the study. The analytical approach is grounded, highlighting its innovative nature and theoretical foundation. Additionally, the relevance and validity of the methodology employed are discussed in relation to the overall objective of the study.

2.1. Yogurt consumption

2.1.1. The product

The Codex Alimentarius (2003) defines yogurt as a variety of fermented milk characterized by a particular culture: Streptococcus thermophilus and Lactobacillus delbrueckii. Fermentation by the latter releases lactic acid, modifying the physical properties of the milk and, consequently, giving the product its distinctive flavor (INNSZ, 2001). Additionally, today various types of yogurt can be found on the market, in varieties that differ in taste, production process, consistency, texture, and therefore chemical composition (Coronel Merizalde, 2019). The heterogeneity of this food leads to its classification into two main groups: set yogurt and stirred yogurt (Hernandez, 2003).

2.1.2. Consumer perceptions and the use of sweeteners

According to Grunert, Bech-Larsen, and Bredahl (2000), there are four dimensions that characterize consumer perception regarding the quality of dairy products: hedonic, health, convenience, and process quality. The authors suggest that while taste remains an essential property in product choice, the other phenomena emphasize the importance of its communication. In line with this idea, an exploratory study by Lacaze (2011) highlights the stability of the health and hedonic dimensions as motivators of consumption, as well as the growing relevance of the convenience dimension.

The acceptance of sweeteners, like any other component of a product, could be addressed from the consumers' perceptions (Kitz et al., 2022). First, a sweetener can be defined as a substance alternative to sugar that imparts a sweet taste to food

(Ministerio de Agricultura, Ganadería y Pesca, 2014). It is classified into two groups: natural and artificial sweeteners. The former are carbohydrates derived from trees, plants, seeds, roots, and nuts, while the latter contain carbohydrate substitutes that replace the natural sweetener due to their low energy value or greater sweetening power (Kumar et al., 2019).

Within the spectrum of sugar alternatives, we delve into the field of natural-origin sweeteners, highlighting honey as a prominent option. It is distinguished by its origin in the process carried out by bees, who transform plant secretions or flower nectar into this fluid. Beyond its function as a sweetener, honey reveals a sweetening potential that surpasses cane sugar, demonstrating twice the capacity (Alonso, 2010).

On a similar note, Stevia stands as an intriguing alternative, recognized for its intense sweetness. In its pure form, Stevia is up to 300 times sweeter than conventional sugar (Andrés González-Moralejo, 2011; Alonso, 2010). However, its distinctiveness lies not only in its taste but also in its safety for individuals with diabetes, as it has no impact on blood glucose levels (Andrés González-Moralejo, 2011).

When considering the introduction of these sweeteners in food products, it becomes imperative to analyze consumer acceptance. A study conducted in the United States focused precisely on evaluating the influence of Stevia concentration on consumers' perceptions regarding vanilla yogurts (Narayanan et al., 2014). The results of this research revealed that the concentration of Stevia in the yogurts not only influenced the perception of sweetness but also the product's acidity. Compared to sucrose, consumers generally expressed a preference for yogurt sweetened with the latter, showing some reluctance toward Stevia. These findings emphasize the need to holistically address the formulation of products incorporating alternative sweeteners, recognizing that consumer acceptance is a crucial factor for market success.

The use of sweeteners has become a widely adopted option by companies, especially in Argentina, where Law 27.642 (2022), known as the front labeling law, has been enacted. This law aims to warn consumers about excess sugars, sodium, and fats in foods by incorporating black hexagons on the front of packaging. This is a relevant aspect considering that, especially after the COVID-19 pandemic, consumers are paying more attention to packaging (Kitz et al., 2022), with consumers showing increased interest in the quality of food, understood in terms of its components (Vanoye-Eligio et al., 2022).

The diversity of natural sweeteners offers a fertile ground for food innovation, but their effective implementation requires a deep understanding of consumer preferences and perceptions. Furthermore, it calls for future research to explore the underlying reasons for these preferences and to refine formulation strategies to maximize consumer acceptability (Narayanan et al., 2014).

2.2. Perceptual maps

Perceptual maps are a fundamental tool in marketing analysis. Their ability to clearly and concisely visualize consumer perceptions of products and brands makes them an invaluable tool for companies in making strategic decisions (De Oliveira Santos and De Jesus Silva, 2015; Ghataty et al., 2023). These maps allow companies to identify how consumers perceive and value product attributes in relation to the competition (Ekiyor and Altan, 2024), providing crucial information for effectively positioning products in the market (Lehmann and Winer, 2007).

In business practice, the use of perceptual maps has become almost indispensable. Companies that wish to remain competitive must thoroughly understand how their products are perceived by consumers and how they compare to competitors' products (Lehmann and Winer, 2007). This deep understanding of consumer perception not only allows companies to position their products more effectively (Yilmaz and Altunay, 2023), but also helps them identify areas for improvement and opportunities for differentiation in today's highly competitive market (De Oliveira Santos and De Jesus Silva, 2015).

Furthermore, perceptual maps can also be used as a tracking tool to assess the effectiveness of positioning strategies over time (Omidvar and Merrikhpour, 2023). By comparing perceptual maps over different periods, companies can identify changes in consumer perception and adjust their strategies accordingly, allowing them to stay agile and responsive to market fluctuations (Lehmann and Winer, 2007).

The application and construction of perceptual maps encompass various approaches, ranging from expert judgment in the sector to direct consumer evaluation of attributes, and even procedures that employ more advanced statistical techniques (Toledo, Giraldi, and De Almeida Prado, 2007; Lehmann and Winer, 2007). In this context, multidimensional scaling stands out as a fundamental statistical procedure for addressing the complexity inherent in the perception of products and brands (Toledo, Giraldi, and De Almeida Prado, 2007).

However, to enrich and strengthen this analysis, some researchers propose combining multidimensional scaling with principal component analysis (Chatfield and Collins, 1980; Gras, 1996). Although these techniques share certain similarities (Rivas and Arias, 1991; Borg and Groenen, 2005), it is crucial to recognize the differences between them, as they may have specific implications when applied in certain contexts (Rivas and Arias, 1991; Abdi and Williams, 2010; Malhotra, 2004).

In this context of perception analysis, it is essential to explore both types of statistical procedures in depth, examining their similarities and differences in order to gain a more comprehensive understanding of the image of products and brands in the market.

2.2.1. Multidimensional scaling

Multidimensional scaling (MDS) emerges as an invaluable tool for the spatial representation of individual perceptions through a perceptual map (Kruskal, 1978; Malhotra, 2004). This approach is based on the analysis of proximity data, emphasizing the relevance of similarity or difference between stimuli (Gras, 1996; Carroll and Chang, 1970; Buja and Swayne, 2002).

The proximity between stimuli, in terms of similarity or difference, constitutes a crucial element in multidimensional scaling (Malhotra, 2004). The spatial representation generated by this procedure translates into a low-dimensional perceptual map, where the geometric distance between stimuli reflects their level of similarity as perceived by the participants (Carroll and Chang, 1970; Cox and Cox, 2008; Linares, 1990). The interpretation of these results is based on the analogy between geometric distance and psychological dissimilarity, highlighting the importance of understanding perceptions from a psychological perspective (Gras, 1996).

Regarding data collection, different approaches have been identified, such as obtaining similarity judgments, attribute ratings, or preference data (Malhotra, 2004; Torgerson, 1958). These methods allow for the collection of valuable information about the perception of stimuli, facilitating their subsequent analysis through mathematical procedures to obtain meaningful distances.

In the realm of multidimensional scaling, the PROXSCAL program stands out as a widely used alternative, due to its availability in major statistical analysis software, such as SPSS. This procedure performs multidimensional scaling of similarity values, seeking a least squares representation that places stimuli in a low-dimensional Euclidean space (Busing et al., 1997). PROXSCAL integrates the perspectives of Kruskal (1964), Guttman (1968), and Carroll (1972), with the goal of minimizing normalized raw stress, an indicator based on the dissimilarities between objects that evaluates the effectiveness of the perceptual map. This integrative approach strengthens the analysis and contributes to a detailed understanding of perceptions.

2.2.2. Principal component analysis

Principal component analysis (PCA) has been highlighted for its ability to efficiently reduce and synthesize complex data. This approach, supported by pioneers in the field such as Wold, Esbensen, and Geladi (1987), represents an essential pillar for understanding the underlying structure of multidimensional data sets (Malhotra, 2004; Wold, Esbensen, and Geladi, 1987).

At its core, PCA aims to extract crucial information from the complex interrelationships present in the data, as highlighted by Lozares Colina and López-Roldán (1991). The procedure seeks to define latent constructs that capture and describe a significant portion of the inherent variability in the data (Abdi and Williams, 2010; Malhotra, 2004).

These perspectives support the utility of PCA in revealing latent patterns in diverse and heterogeneous data (Abdi and Williams, 2010).

The visual representation derived from principal component analysis, as suggested by Rivas and Arias (1991) and Abdi and Williams (2010), not only serves as a graphical reflection of the interconnections between variables but also acts as a revealer of the underlying configuration of latent constructs. This visual aspect not only provides clarity on the underlying structure of the data set but also facilitates the interpretation of intrinsic relationships, thus contributing to a deeper understanding of the inherent complexity of the analyzed data (Rivas and Arias, 1991).

In a broader context, the resulting visualization not only becomes an essential tool for scientific research but also opens the door for more detailed exploration. This graphical representation not only aids in identifying emerging patterns and trends but also serves as a visual guide in formulating hypotheses and making data-driven decisions, thus enriching the scientific research process (Wold, Esbensen, and Geladi, 1987; Rivas and Arias, 1991; Abdi and Williams, 2010).

2.2.3. Multidimensional scaling and principal component analysis: similarities and differences

When addressing the analogies between the mentioned statistical analysis techniques, Rivas and Arias (1991) highlight that both rely on purely mathematical procedures, thus dispensing with normality assumptions, and share similarities in certain phases, especially regarding the determination of eigenvalues and associated eigenvectors of a matrix.

The interpretation of both techniques also presents similarities, as explained by Borg and Groenen (2005). The interpretation of the dimensions in multidimensional scaling is based on the arrangement of the points in the perceptual map, requiring an indirect interpretation based on the researcher's criterion (Kruskal, 1978; Malhotra, 2004). Similarly, the latent variables derived from principal component analysis are defined through the factor weight of each observable variable, and it is the researcher's task to conceptualize the resulting construct (McDaniel and Gates, 2011; Malhotra, 2004). Both analyses converge in their approach towards dimension reduction and the identification of components or latent constructs (Rivas and Arias, 1991; Arce, De Francisco, and Arce, 2010; Kruskal, 1978; Malhotra, 2004; McDaniel and Gates, 2011).

The main distinction between these statistical techniques lies in the procedure used for their execution. Principal component analysis is based on the analysis of covariance matrices, exploring the linear relationships between variables and seeking dimensions that capture the maximum variability. On the other hand, multidimensional scaling operates on proximity or similarity matrices, which consist of association coefficients between stimulus objects, and seeks to represent the relationships between these objects in a lower-dimensional space that preserves, as much as possible, the relationships between the objects in the original space.

Unlike multidimensional scaling, in principal component analysis, the visual arrangement of the points does not reflect the perceptual space of individuals regarding the evaluated stimuli. Instead, the underlying relationships between the variables and components, which represent latent constructs containing some degree of information about the variables, are visualized (Rivas and Arias, 1991; Abdi and Williams, 2010; Malhotra, 2004; Lloret et al., 2014; Joliffe, 2002).

After analyzing the similarities and differences between these techniques, it can be concluded that there is no fundamental identity between them, and they are not interchangeable (Rivas and Arias, 1991). However, practice shows that they are often used together to obtain more comprehensive studies with a higher level of analysis. Additionally, principal component analysis is used to strengthen the interpretation of the dimensions derived from multidimensional scaling (Chatfield and Collins, 1980). According to Gras (1996), multidimensional scaling represents an alternative and complementary technique to principal component analysis for scaling various stimuli in a bi- or multidimensional space.

3. METHODOLOGY

3.1. Objective

The objective of the research was to identify the perceptions and evaluations of consumers regarding the sweeteners used in yogurt production.

3.2. Method and participants

This study has a non-experimental, descriptive, and simple cross-sectional design. The data collection instrument was a self-administered electronic questionnaire that participants answered in person, with data collection taking place in a controlled laboratory environment.

The sampling procedure was non-probabilistic incidental, with the target population being university students from the Metropolitan Area of Buenos Aires, Argentina. Data collection was carried out during the month of July 2023.

A sample of 115 valid cases was obtained, consisting of men (39%) and women (61%) aged 18 to 25 years (M=20.51; SD=2.121).

3.3. Informed consent

Individuals were required to read and accept an informed consent form to continue with their participation. Those who agreed to participate proceeded with the questionnaire, while those who did not agree to participate ended it.

3.4. Analysis procedure

Data analysis was performed using the statistical software SPSS version 25.

First, a multidimensional scaling was conducted using the PROXSCAL program, with the aim of obtaining a spatial representation of individuals' perceptions (Kruskal, 1978). Since the data had been obtained through the attribute rating approach (Malhotra, 2004), the distances were calculated beforehand to later plot the two-dimensional perceptual map using the Euclidean distance measure. The initial configuration of Torgerson (1958) was used with a maximum of 1 iteration, as it tends to produce favorable results regarding the reduction of minimum stress (Borg and Mair, 2017; Davison and Stephen, 1978; Borg and Groenen, 2005).

Next, a principal component analysis was conducted using Varimax rotation. A model was created based on two components.

The visual representations of both analyses were examined to determine whether the grouping of the elements was similar. A similar grouping was indeed observed, so both procedures were analyzed together to enrich the analysis (Chatfield and Collins, 1980; Gras, 1996).

For the interpretation of the dimensions of the perceptual map, variables for the constructs from the principal component analysis were created using regression procedures, which allowed the analysis of the correlation coefficients between these latent variables and other items answered by the participants.

3.5. Limitations

Among the limitations of the study are the sample size, which is relatively small, and the non-probabilistic nature of the sampling procedure.

Additionally, some of the variables analyzed did not follow a normal distribution, which prevented the use of parametric techniques.

4. RESULTS

For the multidimensional scaling and principal component analysis, the ratings of the respondents regarding the following sweeteners were considered: Sugar, Cane Sugar, Stevia, Honey, Fruit Juice, and Whole Sugar. Based on these ratings, the corresponding visual representations were made.

For the multidimensional scaling, first, the distances were calculated, and using the PROXSCAL program with Torgerson's (1958) initial configuration and a maximum of 1 iteration, the spatial grouping shown in Figure 1 was achieved

(the coordinate matrix can be seen in Table 1). The stress indicators and model fit present favorable results: Normalized Raw Stress = .011; Stress-I = .108; Stress-II = .258; S-Stress = .015. On the other hand, the model shows good fit: DAF = .988; Tucker Congruence Coefficient = .994.

Figure 1. Visual representation of the multidimensional scaling

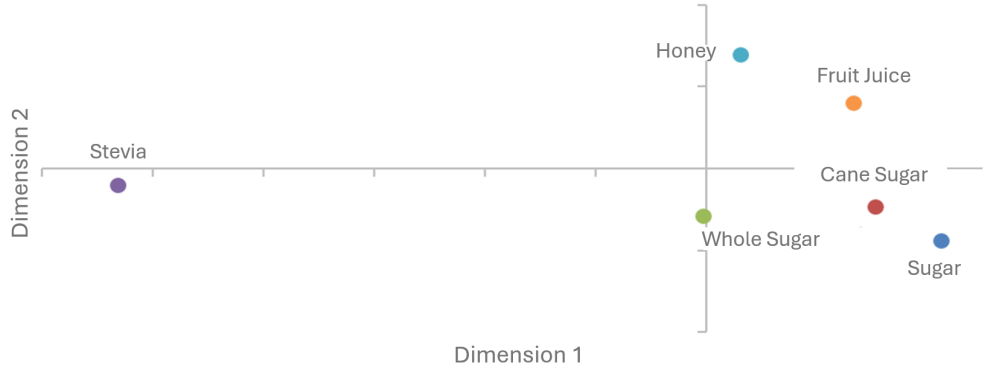


Table 1. Coordinates matrix

	Dimension 1	Dimension 2
Sugar	0.426	-0.445
Cane Sugar	0.307	-0.238
Whole Sugar	-0.003	-0.298
Stevia	-1.06	-0.106
Honey	0.063	0.691
Fruite Juice	0.268	0.396
Program: PROXSCAL. Inicial configuration: Torgerson.		

Subsequently, a principal component analysis with Varimax rotation was conducted to aid in the interpretation of the dimensions previously identified. For this analysis, the same variables used in the MDS were considered, resulting in two groups that explain 68.9% of the variance. The components in the rotated space are displayed in Figure 2, and the rotated component matrix is shown in Table 2.

Figure 2. Visual representation of the principal component analysis.

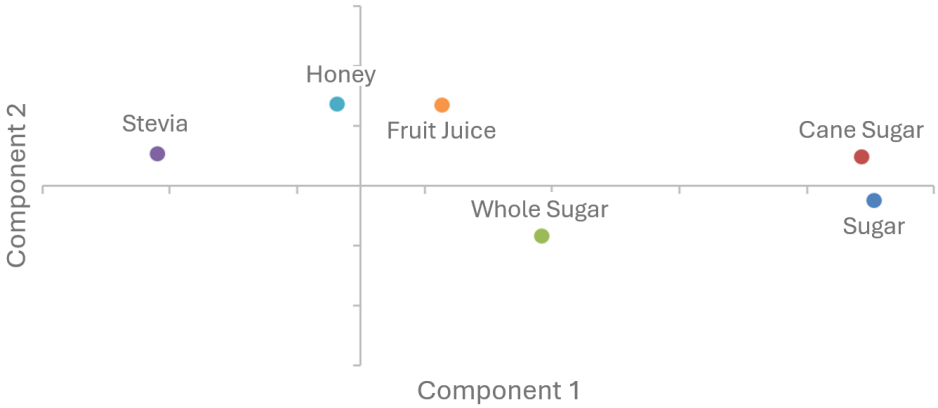


Table 2. Rotated component matrix

	Component 1	Component 2
Sugar	.806	-.129
Cane Sugar	.787	.237
Whole Sugar	.285	-.420
Stevia	-.318	.259
Honey	-.037	.679
Fruit Juice	.128	.668
Extraction method: principal components. Rotation method: Varimax with Kaiser normalization.		

When contrasting the visual representations derived from both analyses, a notable similarity in the arrangement of the elements becomes evident. It is important to recall that it is not appropriate to postulate a fundamental identity between these methodologies. However, the visual convergence suggests that the latent variables projected onto the axes may refer to the same underlying constructs.

To determine the existence and nature of the relationships between the variables associated with Component 1 from the principal component analysis, a bivariate correlation test was conducted, yielding the following results:

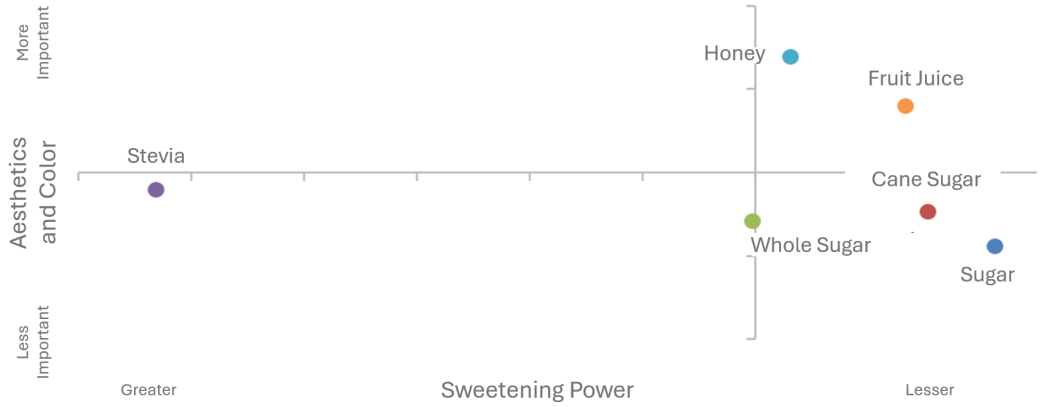
- Component 1 – Importance of sweetness: $r(115)=.640$, $p<.001$;
- Component 1 – "I would like to buy whole sweetened yogurt": $r(115)=-.562$, $p=.005$.

The same procedure was performed for the variables associated with Component 2, with the results for this case being:

- Component 2 – Aesthetic evaluation: r(115)=.512, p=.023;
- Component 2 – Importance of color: r(115)=.487, p=.046;
- Component 2 – "I would like to buy whole fruit-colored yogurt": r(115)=.673, p<.001.

Based on these analyses, Dimension 1 is defined by the variables according to the individual's preference for the "Sweetening Power" of the substance. This refers to the intensity of the sweet taste caused by that substance. Dimension 2 is interpreted as the evaluation of "Aesthetics and Color," with its position on the graph varying depending on the importance given to this attribute. The resulting perceptual map from this analysis can be seen in Figure 3.

Figure 3. Final perceptual map



To conclude, a non-parametric bivariate correlation test was performed based on the variables used in the multidimensional scaling (resulting from the components of the principal components analysis) to reaffirm the previous deductions related to the axes of the perceptual map. The results for the variables related to the Sweetening Power dimension were as follows:

- Importance of sweetness – Sugar: ρ(115)=.617, p=.001;
- Importance of sweetness – Cane Sugar: ρ(115)=.574, p=.003;
- "I would like to buy whole sweetened yogurt" – Stevia: ρ(115)=.892, p<.001;
- "I would like to buy whole sweetened yogurt" – Sugar: ρ(115)=-.640, p=.010.

Meanwhile, for the variables associated with the Aesthetics and Color dimension, the following correlations were observed:

- Importance of color – Fruit Juice: $\rho(115)=.586$, $p=.047$;
- "I would like to buy whole fruit-colored yogurt" – Fruit Juice: $\rho(115)=.821$, $p<.001$;
- Aesthetic evaluation – Honey: $\rho(115)=.545$, $p=.008$.

As a corollary to this section, we can observe that the analysis conducted on the respondents' preferences regarding different sweeteners has yielded interesting and significant results. Through multidimensional scaling and principal component analysis, two main dimensions have been identified that explain a large portion of the variance in the sweetener ratings. This analysis has provided a deep understanding of the respondents' preferences regarding sweeteners, identifying key dimensions that influence their choices. These results can be highly useful for better understanding market preferences and guiding marketing strategies and product development.

5. CONCLUSIONS AND DISCUSSION

In this research, techniques such as multidimensional scaling and principal component analysis were implemented to explore consumer perceptions and evaluations regarding the sweeteners used in yogurt production. A complementary analysis of these procedures was carried out to enrich the analysis, following the recommendations of experts such as Chatfield and Collins (1980) and Gras (1996).

The investigation into the nature of the developed latent constructs was conducted through correlation analysis, thus deepening the understanding of the emerging patterns. This approach allowed the classification of sweeteners along two main axes: the first related to preference based on Sweetening Power, and the second linked to Aesthetics and Color. At the far left of the scale, Stevia is distinguished, highlighting its remarkable sweetening power, consistent with the views of González-Moralejo (2011) and Alonso (2010), and aligning with the conclusions of Narayanan et al. (2014) about the significant effect of this sweetener on yogurt sweetness perception.

Similarly, honey is positioned nearby, with its placement attributed to properties that influence flavor, thus supporting Alonso's (2010) assertion of its superior

sweetening power compared to cane sugar. The remaining variables, such as fruit juice, sugar, and its variants, generally occupy the far right of the scale.

The dimension focused on Aesthetics and Color allowed the classification of sweeteners according to the importance consumers place on these attributes. At the top of this categorization is honey, standing out as the preferred choice for consumers who place greater value on these aspects. In contrast, at the opposite end, sugar is placed, preferred by those who do not prioritize aesthetic qualities.

Through this thorough analysis, the participants' evaluations and perceptions were detailed, graphically represented in a perceptual map covering the various types of sweeteners used in yogurt production.

The results of this research have significant practical implications for the dairy industry, particularly in product formulation and marketing strategies. First, a detailed understanding of consumer preferences regarding sweeteners in yogurt can guide the creation of new products that better align with market demands. For instance, companies could develop yogurt sweetened with Stevia to cater to consumers seeking options with a more prominent sweetening power but fewer calories than sugar.

Furthermore, the classification of sweeteners based on the importance consumers attach to aesthetics and color can influence marketing strategies. Companies could emphasize the visual qualities of yogurts sweetened with honey or fruit juice to attract consumers who value these aspects.

Despite the relatively small sample size, the results obtained are highly significant and provide valuable insights into the study topic. The quality of the data collected, along with the detailed analysis performed, supports the validity and relevance of our conclusions. We acknowledge that expanding the sample in future research could provide a more comprehensive and robust perspective on the findings, allowing for greater generalization of the results.

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6. REFERENCES

Abdi, H., and Williams, L. J. (2010). Principal component analysis. *Wiley interdisciplinary reviews: computational statistics*, *2*(4), 433-459. https://doi.org/10.1002/wics.101

Alonso, J. R. (2010). Edulcorantes naturales. *La Granja*, *12*(2), 3-12. https://doi.org/10.17163/lgr.n12.2010.01

Andrés González-Moralejo, S. (2011). Aproximación a la comprensión de un endulzante natural alternativo, la Stevia rebaudiana Bertoni: producción, consumo y demanda potencial. *Agroalimentaria*, *17*(32), 57-69. https://www.redalyc.org/articulo.oa?id=199218360005

Arce, C., De Francisco, C., y Arce, I. (2010). Escalamiento multidimensional: concepto y aplicaciones. *Papeles del Psicólogo*, *31*(1), 46-56. https://www.redalyc.org/articulo.oa?id=77812441005

Bolsa de Comercio de Rosario. (2023a). *Radiografía del sector lácteo en Argentina.* https://www.bcr.com.ar/es/mercados/investigacion-y-desarrollo/informativo-semanal/noticias-informativo-semanal/radiografia-7

Bolsa de Comercio de Rosario. (2023b). *Valor Agregado y Empleo en el Sector Agroindustrial Argentino.* https://www.bcr.com.ar/es/mercados/investigacion-y-desarrollo/informativo-semanal/noticias-informativo-semanal/valor-agregado

Borg, I., & Groenen, P. J. (2007). *Modern multidimensional scaling: Theory and applications*. Springer Science & Business Media.

Borg, I., and Mair, P. (2017). The choice of initial configurations in multidimensional scaling: Local minima, fit, and interpretability. *Austrian Journal of Statistics*, *46*(2), 19-32. https://doi.org/10.17713/ajs.v46i2.561

Buja, A., and Swayne, D.F. (2002). Visualization methodology for multidimensional scaling. *Journal of Classification*, *19*, 7-44. https://doi.org/10.1007/s00357-001-0031-0

Busing, F. M. T. A., Commandeur, J. J., Heiser, W. J., Bandilla, W., and Faulbaum, F. (1997). PROXSCAL: A multidimensional scaling program for individual differences scaling with constraints. *Softstat*, 97, 67-74. https://www.researchgate.net/publication/244439009_PROXSCAL_A_multidimensional_scaling_program_for_individual_differences_scaling_with_constraints

Carroll, J. D. (1972). Individual differences and multidimensional scaling. In R. N. Shep-ard, A. K. Romney, y S. B. Nerlove (Eds.), *Multidimensional scaling: Theory and applications in the behavioral sciences* (Vol. 1, pp. 105–155). Seminar Press. https://www.researchgate.net/publication/228783570_Multidimensional_Scaling_and_its_Extensions_Applications_to_Perceptual_Preferential_and_Other_Behavioral_Science_Data_Part_II_Examples

Carroll, J.D. y Chang, J.J. (1970). Analysis of individual differences in multidimensional scaling via N-way generalization of Eckart-Young decomposition. *Psychometrika*, *35*, 283-319. https://doi.org/10.1007/BF02310791

Chatfield, C. y Collins, A. J. (1980). Chatfield, C. (2018). *Introduction to multivariate analysis*. Routledge.

Codex Alimentarius (2003). Normas internacionales de los alimentos https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS+243-2003%252FCXS_243s.pdf

Collantes, F. (2014). La evolución del consumo de productos lácteos en España, 1952-2007. *Revista de Historia Industrial*, (55), 103-134. https://revistes.ub.edu/index.php/HistorialIndustrial/article/download/21076/22933/47208

Coronel Merizalde, M. V. (2019). *Análisis de emprendimiento y comercialización de yogurt natural y artesanal como materia prima a locales de comidas rápidas del cantón Balzar* (Bachelor's thesis, Universidad de Guayaquil Facultad de Ciencias Administrativas). https://biblioteca.semisud.org/opac_css/index.php?lvl=notice_display&id=283883

Cox, M. A., and Cox, T. F. (2008). Multidimensional scaling. In *Handbook of data visualization* (pp. 315-347). Springer. https://doi.org/10.1007/978-3-540-33037-0_14

Davison M. L. and Stephen, G.S (1978). Multidimensional Scaling. In Tinsley, H. E., & Brown, S. D. (Eds.). (2000). *Handbook of applied multivariate statistics and mathematical modeling*. Academic press. https://doi.org/10.1016/B978-012691360-6/50013-6

De Oliveira Santos, G. E., y De Jesus Silva, V. (2015). Mapa perceptual como ferramenta para a análise da imagem de destinos turísticos. *Revista de Turismo*

Contemporâneo, *3*(2). https://periodicos.ufrn.br/turismocontemporaneo/article/view/6856

Ekiyor, A., and Altan, F. (2024). Measuring the Brand Value of Selected Toothpaste Companies Using Perceptual Mapping. https://doi.org/10.2139/ssrn.4743536

Ghataty, N. S., Abdelaziz, G. S., and Abdelgawad, D. F. (2023). The relationship between Perceptual Mapping and Marketing Effectiveness in Private Universities in Egypt. *The Academic Journal of Contemporary Commercial Research*, *3*(4), 79-105. https://doi.org/10.21608/ajccr.2023.213854.1061

Gras, J. A. (1996). *Métodos y técnicas avanzadas de análisis de datos en ciencias del comportamiento* (Vol. 22). Edicions Universitat Barcelona. https://books.google.es/books/about/Métodos_y_técnicas_avanzadas_de_análi.html?hl=es&id=VXlz3-Sxuh4C&redir_esc=y

Grunert, K. G., Bech-Larsen, T., and Bredahl, L. (2000). Three issues in consumer quality perception and acceptance of dairy products. *International Dairy Journal*, *10*(8), 575-584. https://doi.org/10.1016/S0958-6946(00)00085-6

Guttman, L. (1968). A general nonmetric technique for finding the smallest coordinate spacefor a configuration of points. *Psychometrika*, *33*, 469-506. https://doi.org/10.1007/BF02290164

Hernández Carranza, P. (2004). *Evaluación de las propiedades fisicoquímicas y reológicas de yogurt bajo en grasa enriquecido con fibra y calcio de yogurt.* [Trabajo fin de Máster, Universidad de las Américas Puebla] https://catarina.udlap.mx/u_dl_a/tales/documentos/mca/hernandez_c_p/

INNSZ. (2001). Ingestión diaria recomendada de energía, proteína, vitaminas y minerales para la población mexicana. *Cuadernos de Nutrición*, *24* (1), 38.

Instituto Nacional de Estadística y Censos (INDEC). (2023). Informe de avance del nivel de actividad. Segundo trimestre de 2023. *Cuentas nacionales*, *7* (18). https://www.indec.gob.ar/uploads/informesdeprensa/pib_09_23E4739771F4.pdf

Jollife, I. T. (2002). Principal component analysis (2nd ed.). Springer.

Kitz, R., Walker, T., Charlebois, S., and Music, J. (2022). Food packaging during the COVID-19 pandemic: Consumer perceptions. *International Journal of Consumer Studies*, *46*(2), 434-448. https://doi.org/10.1111/ijcs.12691

Kruskal, J. B. (1964). Multidimensional scaling by optimizing goodness-of-fit to a nonmetrichypothesis. *Psychometrika*, *29*, 1–27. https://doi.org/10.1007/BF02289565

Kruskal, J. B. (1978). *Multidimensional scaling*. Sage.

Kumar, N., Singh, A., Sharma, D. K., and Kishore, K. (2019). Toxicity of Food Additives. In Lakhan Singh, R and Mondal, S (Eds.) *Food Safety and Human Health* (pp. 67-98). Academic Press. https://doi.org/10.1016/B978-0-12-816333-7.00003-5

Lacaze, M. V. (2011). Valores y motivaciones en el consumo de productos lácteos: un estudio exploratorio con estudiantes universitarios argentinos. *FACES*, *17*(36-37), 49-78. https://eco.mdp.edu.ar/revistas/index.php/faces/article/view/155

Lehmann, D. R., y Winer, R. S. C. (2007). *Administración del producto*. McGraw-Hill. https://www.scribd.com/document/320170268/Administracion-Del-Producto-4ta-Edicion-Donald-R-Lehmann

Ley 27.642 (2022). Ley de etiquetado frontal. Promoción de la alimentación saludable. Ministerio de Justicia y Derechos Humanos de la República Argentina. https://www.argentina.gob.ar/justicia/derechofacil/leysimple/salud/ley-de-etiquetado-frontal

Linares, G. (1990). *Análisis de Datos*. Universidad de La Habana.

Lloret, S., Ferreres, A., Hernández, A. y Tomás, I. (2014). El análisis factorial exploratorio de los ítems: una guía práctica, revisada y actualizada. *Anales de Psicología*, *30*(3), 1151-1169. https://doi.org/10.6018/analesps.30.3.199361

Lozares Colina, C., y López-Roldán, P. (1991). El análisis de componentes principales: aplicación al análisis de datos secundarios. *Papers: revista de sociología*, (37), 031-63. https://doi.org/10.5565/rev/papers/v37n0.1595

Malhotra, N. K. (2004). *Investigación de mercados: un enfoque aplicado*. Pearson educación. https://books.google.es/books?id=SLmEblVK2OQC&lpg=PR1&hl=es&pg=PR1 -v=onepage&q&f=false

McDaniel, C., y Gates, R. (2011). *Investigación de mercados.* Cengage learning. https://www.perlego.com/es/book/2459195/investigacin-de-mercados-

pdf?utm_source=google&utm_medium=cpc&campaignid=20968928115&adgroupid=159035306558&gad_source=1&gclid=EAIaIQobChMI8Mf2gIzkiQMV7C0GAB1h_wonEAMYASAAEgKu1vD_BwE

Ministerio de Agricultura, Ganadería y Pesca (2014). *Alimentos Argentinos*. https://www.alimentosargentinos.gob.ar/HomeAlimentos/Nutricion/fichaspdf/Ficha_24_Edulcorantes.pdf

Narayanan, P., Chinnasamy, B., Jin, L., and Clark, S. (2014). Use of just-about-right scales and penalty analysis to determine appropriate concentrations of stevia sweeteners for vanilla yogurt. *Journal of dairy science*, *97*(6), 3262-3272. https://doi.org/10.3168/jds.2013-7365

Omidvar, G., and Merrikhpour, Z. (2023). Positioning of domestic and foreign brands of household appliances from the viewpoint of consumers and determining their willingness to buy (case study: the opinion of women aged 30-50 in Hamadan city on buyinggas stoves). *Journal of Design Thinking*, *4*(1), 1-12. https://doi.org/10.22059/jdt.2023.368075.1107

Rivas, T., y Arias, R. M. (1991). Relación entre escalamiento multidimensional métrico y análisis de componentes principales. *Psicothema*, *3*(2), 443-451. https://www.researchgate.net/publication/237039307_Relacion_entre_escalamiento_multidimensional_metrico_y_analisis_de_componentes_principales

Toledo, G. L., Giraldi, J. D. M. E., e de Almeida Prado, K. P. L. (2007). Mapa perceptual de marcas próprias: uma investigação das principais marcas de grandes redes supermercadistas no Brasil. *REGE Revista de Gestão*, *14*(4), 77-92. https://core.ac.uk/download/pdf/268313531.pdf

Torgerson, W. S. (1958). *Theory and methods of scaling*. Wiley.

Valenze, D. (2011). *Milk: a local and global history*. Yale University Press. https://www.jstor.org/stable/j.ctt1nq6f4

Vanoye-Eligio, M., del Rosario Martín-Canché, B., Torres-Sauri, K. A., y García-Vela, J. A. (2022). Conocimiento del Etiquetado Nutricional y Contenido de Azúcares Añadidos en Alimentos Procesados en Campeche, México. *Conciencia Tecnológica*, (63). https://dialnet.unirioja.es/servlet/articulo?codigo=8746289

Wacher Rodarte, C. (2014). La biotecnología alimentaria antigua: los alimentos fermentados. *Revista digital universitaria*, *15*(8). https://www.revista.unam.mx/vol.15/num8/art64/

Wold, S., Esbensen, K., and Geladi, P. (1987). Principal component analysis. *Chemometrics and intelligent laboratory systems*, *2*(1-3), 37-52. https://doi.org/10.1016/0169-7439(87)80084-9

Yılmaz, M. K., and Altunay, H. T. (2023). Marketing insight from consumer reviews: Creating brand position through opinion mining approach. *Telematics and Informatics Reports*, 11, 100094. https://doi.org/10.1016/j.teler.2023.100094

Zapata, M. E., Rovirosa, A., y Carmuega, E. (2016). *La mesa argentina en las últimas dos décadas. Cambios en el patrón de consumo de alimentos y nutrientes (1996-2013).* CESNI. https://conuer.com.ar/wp-content/uploads/2024/03/LA-MESA-ARGENTINA-EN-LAS-ULTIMAS-DOS-DECADAS.pdf