VISUAL REVIEW | Vol. 16, No. 4, 2024 | ISSN 2695-9631
International Visual Culture Review / Revista Internacional de Cultura Visual
https://doi.org/10.62161/revvisual.v16.5314

VISUAL TOOLS FOR FOOD SAFETY ASSESSMENT OF BIOTECHNOLOGICAL PRODUCTS

MANUEL IGNACIO CANDO DÍAZ[1], KATHERINE LISSETTE ROMERO VÁSQUEZ[1], DANIEL ADRIÁN CORTEZ TUNJA[1], BRADEN ANTHONY AMAYA VILLAGRAN[1]
[1]State University of Milagro, Ecuador

KEYWORDS

Food
Biotechnological
Nutritional Traffic Light
Food Safety
Nutritional Labeling

ABSTRACT

Visual tools in food safety assessment with nutrition labeling are a crucial approach to facilitate consumers' understanding of nutrition information. These tools include labeling systems such as the nutrition traffic light or warning front labels, as well as mobile applications and interactive websites. They aim to simplify the interpretation of nutrition information and help consumers make healthier food choices. In various contexts, such as Ecuador, these visual tools play a vital role in improving the accessibility and usefulness of nutrition labeling, helping to promote healthier eating and prevent diet-related diseases. Their effective implementation and their impact on public health continue to be areas of evolving research and development.

Received: 12/ 02 / 2024
Accepted: 04/ 07 / 2024

1. Introduction

Actually in Ecuador the use of audiovisual tools is deployed in food safety is an important aspect of people's daily lives, as it contributes to the dissemination of proper nutrition directly affects health and general well-being. in this context, socialization through audiovisual products of nutrition labels play a crucial role in providing detailed information on the composition and quality of the food we consume" (Hernández-Nava et al., 2020).

However, many consumers often find this information confusing or difficult to understand. To meet this need, "visual tools were developed as an innovative and effective solution for assessing food safety through nutrition labeling. These visual tools, ranging from simple graphics to interactive mobile applications"(Santos-Antonio et al., 2019b)are designed to simplify the understanding of nutrition and encourage consumers to make healthy choices.

With this in mind, the current work focuses on the study and analysis of the role of visual tools in food safety assessment, with a particular focus on nutrition labeling. Several ways in which these tools can improve the availability, understanding and usefulness of nutrition information for consumers will be explored (Santos-Antonio et al., 2019a) as well as their impact on the promotion of healthier eating habits and the prevention of diet-related diseases, the "importance and effectiveness of visual tools in food safety, thus creating a solid foundation for further development and policies aimed at improving the quality of nutrition information available to consumers."(Almeida, 2019).

Traffic lights or "semaphores" "are used in the countries of the European Union. In the United Kingdom, in Latin America such as Ecuador. This consists of assigning colors to foods according to the amount of energy, nutrients and nutrients they contain"(Figueroa, 2016). If the content is high, "red is used and means 'stop' or limit consumption, similar to a traffic light instruction"(Rodriguez et al., 2018). Typical contents are shown in yellow, meaning "Caution!" A better example would be marked in green, meaning it has little content and you can take a little more. These are excellent tools to capture the customer's attention when choosing a product based on the color itself.

Audiovisual tools have become valuable allies in this process, allowing the identification and evaluation of possible risks associated with the introduction of biotechnological products into the food chain. This is a global trend that emerged from the process of emergence and integration of industrial agri-food systems that began in the middle of the twentieth century (Freire-Peña herrera & Cevallos-Cevallos, 2019) and is now estimated to move billions of dollars annually. In the process of consolidation, it was necessary to close off peasant production, by physically occupying territories.

In Ecuador, large food companies are well aware of this fact, which is why in recent years "marketing campaigns have been directed at the general public. Audiovisual tools can be valuable allies in this process, making it possible to identify and evaluate the potential risks associated with the introduction of biotechnology products into the food chain." (Torres et al., 2023). They are reaching alarming levels, as most of the "advertised products are beverages and foods with low nutritional value, rich in sugar, saturated fat and salt, and therefore harmful to health. This is also reflected in a WHO systematic review, which found that the sweets and sugars group was the most promoted, followed by the cocoa derivatives, fast foods, breakfast cereals and products groups. It has become. cakes and cookies" (Huallpa Galvez, 2015).

Given that a significant part of the "population suffers from chronic malnutrition, anemia, micronutrient deficiencies, overweight and obesity due to food insecurity, food security in Ecuador is a matter of concern"(Tituaña Puente, 2019).

In this research, we will analyze how these "audiovisual tools have become indispensable to ensure food safety in the context of biotechnology, offering a broad and accurate perspective that contributes to informed decision making and public health protection" (Tello et al., 2021).

Faced with this situation, the government of Ecuador has begun to implement measures to increase food security. The Alimenta Ecuador (AE) Program, "However, effective understanding of nutrition labeling can be a challenge for many consumers, especially those with low levels of nutritional education or difficulties in interpreting complex textual information"(Ruiz De la Cruz, 2018). To address this issue

and promote healthier eating, the "use of visual tools in food safety assessment has become an area of growing interest in Ecuador.

It is estimated that front-of-pack nutrition labeling makes use of "graphic elements that seek to influence the perception of users. Likewise, the communicative effectiveness is linked to the design of the information. In addition, it should be noted that the application of the Front End Nutrition Labeling System is a recent phenomenon in the country, which is why only two of the nine labels have been studied, while the effectiveness of the rest of the labels has not been studied in detail, nor have the rest of the tools been evaluated by users" (Melleu & Scoz, 2019). It is considered that this research can "cause impact in the social sphere due to the fact that, by determining which front labeling is the most effective, it can be used as a basis for the development and evolution of the front nutritional labeling system"(Cantuña Tello et al., 2021). The excessive consumption of processed foods and superfoods, which can lead to a lack of knowledge and understanding of nutrition claims, can also be a source of concern (Trejo Osti et al., 2021).

Waterfield et al.(2020). Regarding the back nutritional labeling, it is established that it is a mandatory tool that, as its name indicates, is applied on the back of the packaging (Royo Bordonada, 2022). In addition, this labeling consists of a panel denominated as nutritional composition or Nutrition Facts Panel and the list of ingredients. The data presented are caloric energy, fiber, sugar, fats, among others (Britos et al., 2018) relevant to mention that, in "regarding studies conducted on this labeling, they point out that the information applied in this labeling turns out not to be fulfilling the objective of guiding users. This statement is due to the fact that the tool turns out to be complex for the interpretation of users" (Bravo, 2017). Therefore, there is much controversy in this area due to the potential risk associated with these innovative biochemical technologies.

The evaluation of the food safety of biotech foods in Ecuador is an important issue at the visual level, opting to make "use of graphic elements such as shapes, typography, color, icons and symbols that are easy to interpret, therefore, the information provided should be brief and direct to avoid confusion in consumers" (Triptolemos, 2022). Likewise, front nutrition labeling consists of two types: summary labeling and specific nutrient labeling (Latin American Center for Rural Development, 2022).

To capture a message through a visual piece, the application of graphic elements is necessary to turn an idea into something visually tangible (Collantes Santos, 2018). On the one hand, to learn more about the elements of expression, Díaz-Díaz (2021), points out that point, line, lights, shadows and texture are included in this definition. He also points out that the forms and consequently the visual messages are created from the use and modification of the line.

For the definition of semiotics, Arribas Plaza (2022)points out that "it is the study of the world of representations and language. Part of this study involves semiotic elements whose classification includes icons, symbols and indexes". On the other hand, Ortega (2023)mentions that the "semiotic approach in communication emphasizes the idea that images are a collection of signs that are linked in some way by the viewer".

As well as "explains that semiotics offers a perspective focused on recognizing and interpreting signs. To complement the previous definitions"(Monroy Gonzáles, 2020). Consumer acceptance "will depend on the associations evoked by the food technology, how natural it seems to consumers and how much they trust the industry that uses it. Personality traits that are important in understanding individual differences include food phobias, aversive susceptibilities, and cultural values"(Hakim et al., 2020).

We examine factors that may explain why "consumers do or do not accept a product, through examples such as genetic engineering, nanotechnology, cultured meat, and food irradiation"(Ferreira et al., 2020). Potential threats to the "food system include food supply crises caused by population growth, climate change, and emergencies such as pandemics. Building more resilient food systems requires disruptive food technology"(Fai et al., 2008).

Greater consumer acceptance of these technologies is expected to be achieved through early consideration of variables that influence consumer perceptions of new food technologies (Jorquera et al., 2015).

The use of technology throughout "semiotic elements are made up of symbols, icons and indexes" (Cepeda Bustos, 2023). However, it should be noted that only symbols and icons are used in front-end labeling. Firstly, the symbol is a semiotic element that signals as a semiotic sign that is not necessarily linked to an object, but is purely conventional"(Garro-Monge, 2017).

The design of information, as defined by Huamanchumo and Medina (2019) is the "art and science of preparing information so that it is understandable to an audience". On the one hand, Cuellar Sánchez et al.(2021), points it out "as a discipline whose objective is to present information in a clear and organized way so that it is easily understood by users". The author Remache Asqui (2024) adds that "information design seeks to promote communicative effectiveness, indicating that the main focus of information design is the user". Likewise, authors Ortiz Martínez (2019),they "agree that information design seeks that the user has the possibility to find the information he/she needs, understand it and use it in an appropriate way".

In the early stages of product development, it is important to take into account consumer feedback. The program Alimenta Ecuador (AE), which is responsible for food safety in Ecuador, was developed by the Ministry of Economic and Social Inclusion (MIES) to help build the socioeconomic and cultural foundations necessary for the Ecuadorian people to exercise their right to food.(Latin American Center for Rural Development, 2022).. The ECB, Ecuador's central bank, states that the economy contracted at a rate as a result of COVID-19, Recession and 7.8 percent of GDP in 2020, generalized in most of its industries, economic and hope for recovery (Freire-Peñaherrera & Cevallos-Cevallos, 2019).

GDP growth of 31% is projected for 2021, but that recovering the is not enough. During the first year, losses were incurred, the percentage of the pandemic in early August. In Ecuador, the population is fully immunized reached 49.128 percent, 9 million of whom. The National Institute of Statistics estimates that by 2020, 69.2 percent, according to the Census of Ecuador (INEC). Ecuadorian households could not cover the expense, Basic Family Basket every month, which explains that only 3 out of 10 households are able to remit this charge (Tituaña Puente, 2019). When examining the percentage (Huallpa Galvez, 2015).

Aesthetic principles are determined by the harmony of the elements. That means that care must be taken to ensure that the features used are proportionate or appropriate. The work is visually balanced and does not overwhelm or distract the viewer. Appropriate with reference to Miranda Llorente (2022) it is suggested that this guideline may be a subjective concept to the opinion of each user. Therefore, it is recommended to understand the cognitive knowledge. Enter the number of audience members. Finally, the cognitive principles refer to the attention of the audience, ie.

Attention focuses on perception, memory, learning and understanding of information. These principles speak of three basic principles: attention, perception and information processing (Sillero Rejón, 2020). Processing ensures that users can understand the information provided. This is because speech can be processed and interpreted in different cultural ways. How this works varies from one user to another. It also seeks consistency in the use of color, form and text (Hidalgo Bermeo, 2019).

2. Methodology

Audiovisual tools play a crucial role in biosafety assessment by providing a graphical and understandable representation of complex data and interrelated processes. These tools make it possible to visualize patterns, identify correlations and effectively communicate results to diverse audiences. Graphs, diagrams and visual maps can be used to illustrate the food chain, from genetic modification to production and consumption, helping to identify potential hotspots and assess risks.

Figure 1: Advertising warning.



Source: Manual de advertencia publicitaria (Arribas Plaza, 2022)

The sizes that we observe in Figure 1, will be located on the front, in the upper right area, if the product requires more than one warning will go in the following order; High in Sodium, High in Sugar, High in Saturated Fat and finally Contains Trans Fat, the size is established in four sizes, in addition, the visual representations facilitate the interpretation of epidemiological and toxicological data, which is essential to assess the safety of biotechs in the food chain. Ultimately, the incorporation of visual tools in the food safety assessment of biotechs not only improves scientific understanding, but also promotes transparency and public confidence by providing accessible and clear information about these technological advances in food production.

We used the database of the "Food Security and Food Security Survey (ESAA), part of the Siembra Desarrollo Project. Smallholder Agriculture and Food Resilient to Covid-19, which is supported by the International Development Research Centre (IDRC) of Canada."(Latin American Center for Rural Development, 2022) and its purpose is to compile, "systematically and in accordance with a scientific methodology, useful or necessary background and knowledge to influence different spheres of public action, which will make it possible to promote development processes in Latin American countries. The objective sample was considered 1312 households equally distributed among them, excluding the city, the provinces of Los Rios (656 samples) and Guayas (656 samples), Guayaquil"(Rural, 2022). Table 1 below shows Cronbach's alpha for each dimension.

Table 1. Cronbach's alpha α by dimension

Dimensions	**Cronbach's alpha**
Food Safety.	0,8434
Consumption Patterns	0,8025
***Nutritional* Labeling**	0,7243

As basic references we use the theory of the book "Análisis de datos multivariantes" Peña (2002). It is desired to "find a subspace of dimension less than $\boldsymbol{\rho}$ that when the points are projected on it, they keep their structure with the least possible distortion, the minimum loss of information, such that when the original variables are replaced by a new variable $\boldsymbol{\rho}$ original variables by a new variable, $\boldsymbol{Z_1}$ which optimally summarizes the information. The first principal component will be the linear combination of the original variables that has maximum variance". The values of this first component in the $\boldsymbol{n}$ individuals will be represented by a vector $\boldsymbol{Z_1}$, given by

$$\boldsymbol{z_1 = X a_1 = a_{11} x_1 + a_{12} x_2 + \ldots\ldots + a_{1p} x_p}$$

The original variables have zero mean will also have zero mean. $\boldsymbol{Z_1}$ will have zero mean. Their variance will be:

$$Var(Z_1) = \frac{1}{n} Z_1' Z_1 = \frac{1}{n} a_1' X' X a_1 = a_1' S a_1$$

Where S is the "matrix of variances and covariances of the observations. What is desired is to maximize the variance with the constraint that $a_1' a_1 = 1$. We will introduce this constraint by means of the Lagrange multiplier and then derive with respect to the components of a_1 and equaling to zero, and we obtain the solution":

$$S a_1 = \lambda a_1$$

Which implies that a_1 is an eigenvector of the matrix S, and λ its corresponding eigenvalue. The value of λ is the variance of $Z_1$and, since the aim is to maximize λ will be the largest eigenvalue of the matrix S. Its associated vector, $a_1$defines the coefficients of each variable in the first principal component.

In order to be able to represent the "X variables in a two-dimensional plane, the second component must be calculated, having as objective function that the sum of the variances of z_1=Xa_1 y z_2=Xa_2 is maximum, where a_1 y a_2 are the vectors defining the plane". The objective function will be:

$$\phi = a_1' S a_1 + a_2' S a_2 - \lambda_1 (a_1' a_1 - 1) - \lambda_2 (a_2' a_2 - 1)$$

Incorporating the restriction that addresses must have a unit module. $a_i' a_i = 1, i = 1, 2$. After deriving and equaling to zero the solution is obtained:

$$S a_1 = \lambda_1 a_1$$

$$S a_2 = \lambda_2 a_2$$

The values "de λ_1 y λ_2 must be the two largest eigenvalues of the matrix S y a_1 y a_2 their corresponding eigenvectors. The covariance between z_1 y $z_2$given by $a_1' S a_2$ is zero since $a_1' a_2 = 0$and the variables z_1 y z_2 will be uncorrelated.

In general, the matrix X y S has rank pThere are then as many principal components as variables, which will be obtained by calculating the eigenvalues or characteristic roots, $\lambda_1, \ldots, \lambda_p$of the variance and covariance matrix of the variables, by means of":

$$|S - \lambda \mathrm{I}| = 0$$

And its associated vectors are:

$$(S - \lambda_i \mathrm{I}) a_i = 0$$

The terms λ_i are real, since the matrix is symmetric S symmetric, and positive, since S is positive definite, the associated vectors are orthogonal.

Calling Z to the matrix whose columns are the values of the components in the p components in the individuals n individuals, these new variables are related to the original ones by means of:

$$Z = XA$$

Where $A' A = \mathrm{I}$. Calculating the principal components is equivalent to "applying an orthogonal transformation A to the variables X to obtain new variables Z variables that are not related to each other. This operation can be interpreted as choosing new coordinate axes, which coincide with the natural axes of the data, we consider as basic references the theory of the book New Methods of Multivariate Analysis by Carles M. Cuadras" (2007). In the following we present some criteria to determine the number of principal components that help to give a good summary of the data.

A Biplot for "a data matrix X is a graphical representation using markers (vectors): a1,a2,...,an for the rows of X and b1,b2,...,bp for the columns of X, such that the inner product approximates the element xij of the starting matrix as well as possible".

Both the markers ai for the rows and the markers bj for the columns will be represented in a space of dimension q≤r , where q is the number of retained axes and r is the rank of X. If we consider the markers a1,a2,...,an as rows of a matrix A and the markers b1,b2,...,bp as rows of a matrix B, then we can write":

$$\boldsymbol{X \cong AB^T}$$

The structure of the matrix X can be visualized by representing the markers in a q-dimensional Euclidean space. Generally, we try to take q as small as possible, depending on whether there are significant covariation structures between the columns of X or not.

In this method we try to find a matrix X(q) of rank q, which best approximates X, in the least squares sense. $\left(\boldsymbol{X \cong X_{(q)} = A_{(q)}B^T_{(q)}}\right)$more specifically, it is to find a matrix X(q) of rank q that minimizes the expression:

$$\sum_i \sum_j \left(\boldsymbol{x_{ij} - x_{(q)ij}}\right)^2 = \boldsymbol{traza}\left(\left(\boldsymbol{X - X_{(q)}}\right)\left(\boldsymbol{X - X_{(q)}}\right)'\right)$$

for all matrices X(q) of rank q or less.

The best known method for approximating a low-rank matrix is the one proposed by Eckart & G Young (1936, 1939) which can also be found in Young & AS Householder (1938), Gabriel (1971), Greenacre (1984), among other authors. It is based on the decomposition into singular values and vectors of the matrix that we wish to approximate (Calderón, 2021).

Decomposition into singular values and singular vectors of the matrix X:

$$X = UDV'$$

where U is the matrix whose columns contain the eigenvectors of XX' and V is the matrix whose columns correspond to the eigenvectors of X'X, while D is a diagonal matrix containing the singular values of X.

It must be satisfied that U'U=V'V=I, that is, the columns of U and V are orthonormal, this property assures the uniqueness of the factorization".

The best approximation in rank q, X(q) of X is given by:

$$\boldsymbol{X_{(q)_{nxp}} = U_{(q)_{nxq}} D_{(q)_{qxq}} V'_{(q)_{qxp}} = \sum_{k=1}^{q} \lambda_k u_k v'_k}$$

where, U(q) and V(q) are the matrices constructed with the q first columns of U and V respectively, while D(q) is the diagonal matrix containing the q largest nonzero singular values of X(λk).

An algorithm for "the calculation can be found in Golub & Reinsch(1971).

Therefore, we have:

$$X = AB' = UDV'$$

This implies that the choice of markers for rows and columns can be made in several ways: For example, taking A=UD and B=V or A=U and B=VD' among other factorizations. For this reason, several authors propose different choices and study their properties according to the chosen factorization. However, the interpretation of the Biplot is always performed from the scalar products, regardless of the chosen factorization"(Gamboa, Bermeo-Paucar, Arcos, & Cisneros, 2022).

The usual way to choose the markers is to perform the decomposition:

$$A=UD\gamma \; B=VD1-\gamma$$

Gabriel (1971)proposes various choices of γ to which he gives different names and for which he demonstrates some of their properties.

With γ=1 we obtain:

$$A=UD \; B=V$$

It is verified that B'B=I and we have the JK-Biplot which preserves the metric for the rows. With γ=0 we obtain:

$$A=U \; B=VD$$

It is verified that A'A=I and we have in this case the GH-Biplot which preserves the metric for the columns.

In general, we have called the marker matrices, A for the rows and B for the columns, hereafter we will call them differently for each type of BIPLOT, for example: GH-Biplot (A=G B=H); JK-Biplot (A=J B=K); HJ-Biplot (A=J B=H). This will allow us to identify the different Biplots".

The properties of the row and column markers in the representation depend on the chosen factorization, which depends on the metric introduced in the row space or column space (Hidalgo et al., 2022).

The sample was distributed among the provinces as follows: Los "Rios in the province there are households equally divided with 50% in rural areas and 50% in urban areas, Guayas, with 60% living in urban areas and the other 40% in rural areas. With a margin of error of 5% with 95% confidence. To evaluate, it was suggested to survey the same households that were surveyed in round 1, similar target group (panel sample) changes over time. However, it was supported by evidence"(Arellano & Figueroa, 2022). It was found that 49 percent "of the phone numbers were ineligible, representing a high percentage of useless numbers. Forty-four percent of them answered the call and left a message or simply hung up. While 2 percent of the respondents picked up the phone, but refused to take the survey (Gamboa et al., 2022).

Figure 2: The nutritional traffic light of food



Source: Manual de advertencia publicitaria (Arribas Plaza, 2022)

The red color is used when the amount of the food component is high and the recommendation is to limit its consumption. Similarly, the yellow color is used when the nutrient is in the intermediate and the food comprises a good purchase, but in minimal quantities. Finally, green is used when the food ingredient content is low and is considered the best purchase option. The quantity range used to define a color is considered low, medium or high.

A survey of households was then used as the basis for a cellular telephony base. based on a stratified sampling frame at the provincial level with representativeness at the urban and rural levels. With the help of this new source, a total of 1001 households were surveyed, in addition to the city of Guayaquil, in the two provinces"(Perez, 2019).

Bivariate and multivariate analysis was performed to determine the normality of the data distribution and the Chi-square test for testing the hypotheses raised, the data were processed with the statistical package SPSS 25(Trejo et al., 2018).

3. Results

The results of the research are generally defined to determine the relationship between the responses of the Food Security, Consumption Patterns and Nutrition Labeling dimensions, a principal component analysis (PCA) was performed (Gutierrez Sanchez, 2008).(Gutiérrez Sánchez, 2008).. The correlation matrix between all variables was also obtained from this analysis.

The significance of the factor model (or the extraction of the factors) was evaluated by means of the KMO test (Kaiser, Meyer and Olkin) and Bartlett's test of sphericity with a significance level of 0.05.(De la Fuente Fernandez, 2011)and Bartlett's test of sphericity therefore shows that the correlation matrix is different from the identity matrix (Calderón et al., 2019). See Table 2.

Table 2 KMO and Bartletta Test

Kaiser-Meyer-Olkin measure of sampling adequacy		0,907
Bartlett's test for sphericity	**Approx. chi-square**	2541,922
	gl	300
	Sig.	0
a. It is based on correlations		

The factors were then extracted by means of principal component factor analysis and Varimax rotation. The results of the Kaiser rule showed 2 principal components that explained 85.9% of the total variance (Calderón et al., 2022). (Table 3).

Table 3. Correlations with the original variables

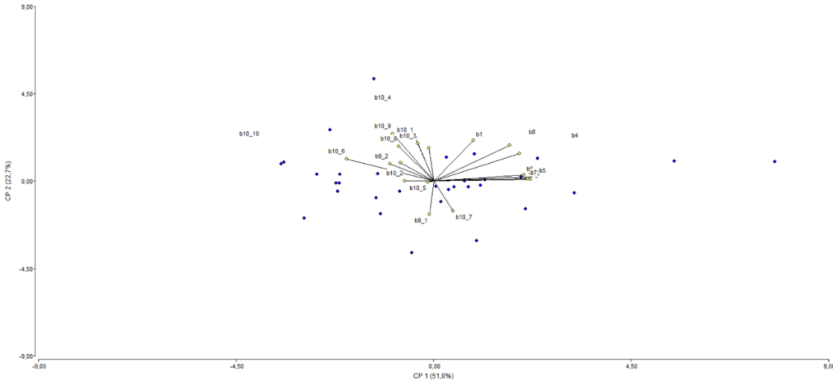
Variables	CP 1	CP 2
b1	0,36	0,54
b2	0,87	0,02
b3	0,84	0,03
b4	0,78	0,36
b5	0,93	0,06
b6	0,82	0,09
b7	0,85	0,03
b8	0,69	0,47
b9_1	-0,03	-0,43
b9_2	-0,39	0,22
b10_1	-0,17	0,57
b10_2	-0,26	1,50E-03
b10_3	-0,14	0,5
b10_4	-0,04	0,44
b10_5	-0,05	-0,01
b10_6	-0,79	0,29

b10_7	0,18	-0,39
b10_8	-0,32	0,46
b10_9	-0,37	0,62
b10_10	-0,3	0,24

Cophenetic correlation= 0.859

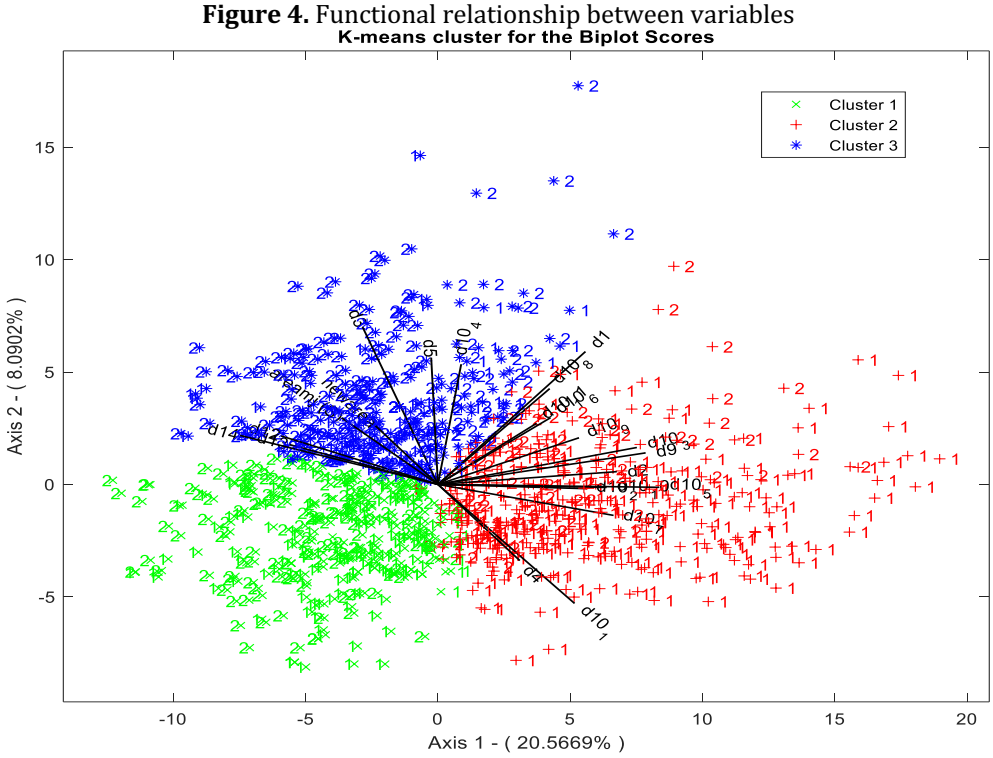
With the principal component analysis, we can observe the variables with the highest contribution for component 1, axis (PC 1) it is observed that the variables b2 with 0.87, b3 with 0.84, b4 with 0.78, b5 with 0.93, b6 with 0.82, b7 with 0.85 are the best represented in this component, which are of the Food Security dimension, presented a positive linear correlation with respect to the other component (P<0.05) (Table 3). On the other hand, the variables with the lowest contribution for component 2 (CP 2) were b10_2 with 1.5E-03, b10_5 with -0.01, b10_6 with 0.29, b10_7 with -0.39.

Figure 3. Functional relationship between variables



The PCA shows that the percentage of variance explained by the first two axes, CP1 with 51% loading and CP2 with 22.7% loading. The results of the study show that, in general, food safety; are rated as good with 51.89 %, biotech foods with 37.49 %,(Calderon et al., 2022)..

Figure 4. Functional relationship between variables



According to the previous figure, it is generally observed that the lowest scores in the Home Resources dimension are also associated with low scores in the Consumption Patterns dimension, while the scores in both aspects also show the same relationship (Mier Pérez, 2022).(Mier Pérez, 2022). This behavior makes it clear that in general, as Consumption Patterns improve, Nutrition Labeling improves.

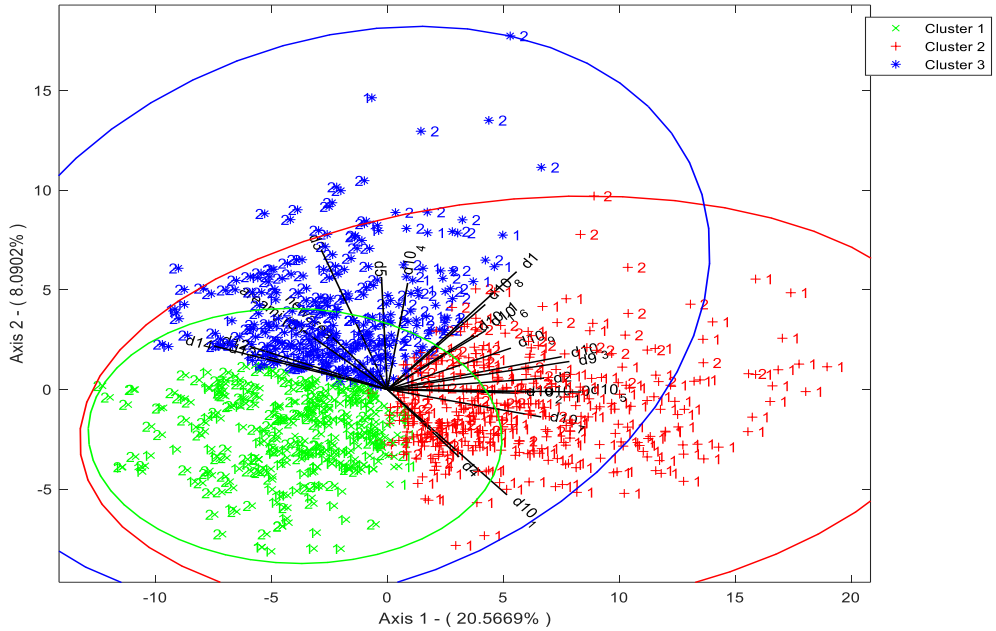
Table 4. Correlation analysis between variables

			Food Safety
Spearman's Rho	**Nutritional Labeling**	**Correlation Coefficient**	,811**
		Sig. (bilateral)	0
		N	1001

**. Correlation is significant at the 0.01 level (bilateral).

Upon finding non-parametric data, Spearman's Rho correlation was applied, finding a high relationship (RS: 0.811) between food safety and Nutrition Labeling which are also highly significant at (P<0.05).

Figure 5. Biplot



In the absence of technical knowledge, consumers often rely on direct or heuristic cues, such as their perception of the naturalness of food technology, their aversion to the unknown and their trust in the food industry.

Table 5. Principal Normalization (Baricentric Scaling)

	Inertia		
Axis	Eigenvalue	Expl. Var.	Cummulative
Axis 1	4319.047	20.567	20.567
Axis 2	1698.944	8.09	28.657
Axis 3	1363.65	6.494	35.151
Axis 4	1351.807	6.437	41.588
Axis 5	1186.871	5.652	47.24
Axis 6	1113.095	5.3	52.54
Axis 7	989.707	4.713	57.253
Axis 8	907.61	4.322	61.575
Axis 9	894.585	4.26	65.835
Axis 10	833.233	3.968	69.803
Axis 11	790.266	3.763	73.566
Axis 12	764.018	3.638	77.204
Axis 13	729.594	3.474	80.678
Axis 14	704.984	3.357	84.035
Axis 15	664.668	3.165	87.2
Axis 16	613.55	2.922	90.122
Axis 17	597.936	2.847	92.969
Axis 18	560.183	2.668	95.637
Axis 19	481.335	2.292	97.929
Axis 20	434.917	2.071	100

The positive and significant correlations confirm the fact that as Food Safety improves, Nutrition Labeling improves.

4. Conclusions

The use of audiovisual tools in biotechnology food safety assessment emerges as an essential component in the understanding and effective communication of the complex processes associated with genetic modification and food production. These tools not only facilitate the identification of potential hazards and critical points in the food chain, but also improve the interpretation of epidemiological and toxicological data.

Difficulty in distinguishing between nutrients and their concentrations, sensory functions of foods, so it is necessary, food industry claims about the nutritional properties of food labels so that customers can choose to make an informed purchase where appropriate.

Most people expect the use of labels to have a positive effect on their health, in addition to education and proper nutrition. Using labels as a food information tool, after industrialization, you can estimate calories and nutrients consumed according to daily needs and maintain the right balance, thus promoting. Health promotion from food. People with obesity problems, have any significant comorbidity such as diabetes, hypertension, people with elevated blood lipids or who need to follow a special diet plan hopefully, will be able to use labels to choose which foods to include?

By providing clear and accessible graphical representations, transparency is promoted and public confidence is strengthened by providing understandable information on biotechnological advances in food production. The role of visual tools is not only limited to the scientific sphere, but also plays a crucial role in promoting effective communication between scientists, regulators and the general public, thus contributing to a more informed and balanced approach to biosafety-related decision-making.

The literature on consumer perceptions of new food technologies (especially genetic engineering (GT), nanotechnology, cultured meat and food irradiation) related to food production, preparation and preservation.

The term "novelty" refers to the introduction of a technology into the market, not necessarily to its invention. Although food irradiation was developed in the last century, it has only recently been introduced in some countries, and because irradiated foods are accepted in some countries but not in others, we still consider it to be a new technology. We do not examine how experts rate agrifood technologies, but only focus on the factors that influence consumer attitudes and acceptance of such technologies.

According to the correlation analysis, Food Safety shows a relatively high correlation with Biotechnology Foods and with its dimensions respectively. The correlations found evidenced a significance, Sig.=0.000, lower than 0.05, which leads to reject the null hypothesis and accept the alternative research hypothesis, which indicates that Food Safety significantly influences Biotech Foods.(Shahjahan et al., 2022).. The positive sign of the correlations confirms the positive relationship that exists between the variables investigated, which allows inferring that as Food Safety improves, Biotech Foods improves. As for the effectiveness of the front-end nutrition labeling system in the purchase decision, it indicates that it can significantly improve it, promoting users to opt for healthier products. This is evidenced by the fact that the majority of users participating in this research indicate that the labeling invites them to reflect on the purchase of certain products.

Individual differences in people's attitudes toward food technology can be explained by many personality traits, such as food phobias and food aversions. Discuss the key factors that influence consumer acceptance of a particular food technology.

References

Almeida, I. B. P. (2019). Biotechnology contributions to rice improvement in Ecuador. *Revista Científica ECOCIENCIA*, *6*(5), 1-22. https://doi.org/10.21855/ecociencia.65.225

Arellano, Y. C., & Figueroa, N. V. D. (2022). Plant genomic editing: A biotechnological tool to ensure food security. *IBIO Journal of Scientific Dissemination*, *4*(3), 19-21. https://doi.org/10.1186/s44330-024-00003-6

Arribas Plaza, A. del C. (2022). *Global front-end nutrition labeling systems. Utility of the Nutri-Score System*. (Trabajo Fin de Grado, Universidad de Valladolid). https://uvadoc.uva.es/handle/10324/54373

Bravo, E. (2017). On how sanitary and food safety standards threaten peasant production in Ecuador. *Antropología Cuadernos de Investigación*, *17*, 56. https://doi.org/10.26807/ant.v0i17.89

Britos, S., Borg, A., Guiraldes, C., & Brito, G. (2018). Review on Front-of-Food Labeling and Nutrient Profiling Systems in the framework of Public Policy design. *Date Retrieved From Document*, *5*, 2018.

Calderón Cisneros, J., Babici, V. R., Muñiz, A. P., & Ronquillo, E. A. (2022). Defunciones fetales como problema o naturalidad de la madre: Fetal deaths as problem or nature of the mother. *Revista Científica Ecociencia*, *9*, 209-221. https://doi.org/10.21855/ecociencia.90.762

Calderón Cisneros, J., Chimbo, K. M., Trejo, C. A., Valdez, K. G., & Villardón, J. L. (2019). Multivariate Analysis of Emotional Aspects and Multiple Intelligences in the Digital Era. *Revista Ibérica de Sistemas e Tecnologias de Informação*, *2*(18), 234-244.

Calderón Cisneros, J. T. (2021). Functional data analysis (FDA) applied to the main causes of mortality in Ecuador 1997-2021: a demographic study. (Tesis Doctoral, Universidad de Salamanca). http://hdl.handle.net/10366/149339

Cantuña Tello, G., Ordoñez Torres, C., Ayala, J. L., & Ortiz, P. (2021). Nutritional labeling of processed foods (nutritional traffic light) and its relationship with socioeconomic, cultural, demographic and advertising factors, according to parents of children aged 5-11 years from two schools in Quito. *Revista Ecuatoriana de Pediatría*, *22*(3), 1-14. https://doi.org/10.52011/133. https://doi.org/10.52011/133.

Latin American Center for Rural Development (2022). MANUAL METODOLOGÓGICO Encuesta de Seguridad Alimentaria y Alimentación. *Rimisp*.

Cepeda Bustos, M. T. (2023). *Analysis of marketing strategies used at the point of sale for the promotion of food products aimed at the Spanish school population*.

Collantes Santos, I. I. (2018). *Evaluation of the use of the nutritional traffic light label in the Central District of Quito*. Quito: Universidad de las Américas, 2018.

Cuadras, C. M. (2007). *NEW METHODS OF MULTIVARIATE ANALYSIS.* http://www.est.uc3m.es/esp/nueva_docencia/getafe/estadistica/analisis_multivariante/doc_generica/archivos/metodos.pdf

Cuellar Sánchez, D. M., Currea Botero, J. S., Mesa Sáenz, S. A., Socha Miranda, E. C., & Vargas Peñaloza, A. F. (2021). *Best practices of frontal food labeling and its impact on the population of Bogotá*. Specialization in Project Management.

De la Fuente Fernandez, S. (2011). Simple and Multiple Correspondence Analysis. *Fac. Economics and Business Administration*, 58.

Diaz-Diaz, P. S. (2021). *Randomized controlled trial on the effect of two interpretive front-end nutrition labeling systems (warning labels vs. Nutri-Score) on food and beverage purchase intentions*.

Eckart, C., & G Young (1936). The approximation of one matrix by another of lower rank. *Springer.* https://idp.springer.com/authorize/casa?redirect_uri=https://link.springer.com/article/10.1007/BF02288367&casa_token=GjQdQSNZfPoAAAAA:vTEn95qG7-qE0eABwCZMRkaX-QQ4UA4NTe0ucHMYBh0Z3iEtyapQrFDfyPm9vKL3hWf6dDSLbj8QT1Zy

Eckart, C., & G Young (1939). A principal axis transformation for non-Hermitian matrices. *Ams.Org.* https://www.ams.org/bull/1939-45-02/S0002-9904-1939-06910-3/

Fai, A. E. C., Stamford, T. C. M., & Stamford, T. L. M. (2008). Biotechnological potential of chitosan in food preservation systems. *Revista Iberoamericana de Polímeros*, *9*(5), 435-451.

Ferreira, C. C. C. B., de Oliveira, S. de O. L., & Rosanova, C. (2020). Biotecnologia. *Encontro Internacional de Gestão, Desenvolvimento e Inovação (EIGEDIN)*, *4*(1).

Figueroa, D. (2016). Measuring food and nutrition security. *Journal of Public Health and Nutrition*, *1*, 1-30. https://sga.unemi.edu.ec/media/archivomateria/2022/05/28/archivomaterial_2022528192356.pdf.

Freire-Peñaherrera[1] , A., & Cevallos-Cevallos-Cevallos, J. M. (2019). *Advances in Biosciences and Food Safety in Ecuador-2019*.

GABRIEL, K. R. (1971). The biplot graphic display of matrices with application to principal component analysis. *Biometrika*, *58*(3), 453-467. https://doi.org/10.1093/biomet/58.3.453

Gamboa, M. A. C., Bermeo-Paucar, J., Arcos, A. A. V., & Calderon Cisneros, J. T. (2022). Virtual learning in public education and its influence on academic performance. *Revista Ibérica de Sistemas e Tecnologias de Informação*, *E53*, 73-86.

Gamboa, M. A. C., Bermeo-Paucar, J., Arcos, A. A. V., & Cisneros, J. T. C. (2022). Virtual learning in public education and its influence on academic performance. *Revista Ibérica de Sistemas e Tecnologias de Informação*, *E53*, 73-86.

Garro-Monge, G. (2017). Crop and biotech food safety, "20 years of commercialization." *Tecnología En Marcha Journal*, *30*(2), 67-74.

Golub, G. H., & Reinsch, C. (1971). Handbook Series Linear Algebra Singular Value Decomposition and Least Squares Solutions*. In *Springer* (Vol. 14). http://people.duke.edu/~hpgavin/SystemID/References/Golub+Reinsch-NM-1970.pdf.

Gutiérrez Sánchez, R. (2008). Correspondence Analysis. *Multivariate Analysis For Sociologists Using SPSS*, 106-116.

Hakim, M. P., Zanetta, L. D., de Oliveira, J. M., & da Cunha, D. T. (2020). The mandatory labeling of genetically modified foods in Brazil: Consumer's knowledge, trust, and risk perception. *Food Research International*, *132*, 109053.

Hernández-Nava, L. G., Egnell, M., Aguilar-Salinas, C. A., Córdova-Villalobos, J. Á., Barriguete-Meléndez, J. A., Pettigrew, S., Hercberg, S., Julia, C., & Galán, P. (2020). Impact of different food front labeling according to nutritional quality: a comparative study in Mexico. *Public Health of Mexico*, *61*, 609-618.

Hidalgo Bermeo, V. M. (2019). *Incidence of product traffic light and marketing strategies proposal for the purchase decisions of consumers in the city of Cuenca*. University of Azuay.

Hidalgo, J. F. H., Moreira, D. S. R., Pihuave, G. B., & Calderon Cisneros, J. T. (2022). Importance of ISO standards in industrial processes from computer science. *Revista Ibérica de Sistemas e Tecnologias de Informação*, *E53*, 306-317.

Huallpa Galvez, L. (2015). *The importance of transgenic foods and their effects on food security*.

Huamanchumo Neciosup, R. S., & Medina Ellen, C. M. (2019). *Implementation of Semaphore system to improve the delivery of products per order in the area of Electro Tottus Chiclayo Open, 2019*.

Jorquera, D., Galarce, N., & Borie, C. (2015). The challenge of controlling foodborne diseases: bacteriophages as a new biotechnological tool. *Revista Chilena de Infectología*, *32*(6), 678-688.

Melleu, P. F., & Scoz, M. (2019). Diretrizes projetuais para sistemas de advertência em embalagens de alimentos ultraprocessados| Guidelines for Warning Labels on Ultra-processed Food Packaging. *InfoDesign-Revista Brasileira de Design Da Informação*, *16*(3), 373-387.

Mier Pérez, L. (2022). La enseñanza de la didáctica de la lengua y la literatura en educación superior: los retos durante la pandemia COVID-19 y la relación del alumnado con la tecnología. *La Enseñanza de La Didáctica de La Lengua y La Literatura En Educación Superior: Los Retos Durante La Pandemia COVID-19 y La Relación Del Alumnado Con La Tecnología*, 131-142.

Miranda Llorente, Y. (2022). *Analysis of marketing techniques and nutritional quality of food products promoted in the Instagram accounts most followed by Spanish adolescents*.

Monroy Gonzáles, E. O. (2020). *Development of a visual communication strategy for SOS Children's Villages, with emphasis on persuading Guatemalans to become SOS friends. Guatemala, Guatemala.* University of San Carlos de Guatemala.

Ortega Antolín, P. (2023). *Comparative analysis of front-of-pack nutritional labeling of food product packaging developed and implemented worldwide*.

Ortiz Martínez, P. A. (2019). *Do nutrition labeling help to improve consumers' eating habits?*

Peña, D. (2002). *Multivariate Data Analysis. Madrid: McGraw Hills.* https://scholar.google.es/scholar?hl=es&as_sdt=0%2C5&q=Peña%2C+D.+%282002%29+"Análi

sis+de+Datos+Multivariantes.".+Madrid%2C+España&btnG=

Pérez, I. (2019). Biotechnology contributions to rice breeding in Ecuador. *Revista Científica Ecociencia* , *6*(5), 1-22. https://doi.org/10.21855/ecociencia.65.225

Remache Asqui, R. M. (2024). *Visual influence of packaging on the purchase decision of private label products in different supermarkets in the city of Riobamba.* Riobamba.

Rodríguez, E. J. J. O., Insuasti, J. P., Trujillo, A. S. D., Andrés, G., Castro, P., Arroyave, C. P. S., & Soto, C. A. P. (2018). Edible mushroom production in the face of Ecuador's food crisis. *Biorefinery Journal Vol*, *1*(1).

Royo Bordonada, M. Á. (2022). The battle of interpretive front-end labeling in Spain. In *Gaceta Sanitaria (*Vol. 36, pp. 97-99). SciELO Public Health. 10.1016/j.gaceta.2021.08.007

Ruiz De la Cruz, A. D. (2018). *Analysis of consumer perception towards the labeling of processed foods containing transgenic" ingredients"*. (Máster Tesis, Universidad de Quito). http://bibdigital.epn.edu.ec/handle/15000/19091

Rural, C. L. for D. (2022). SURVEY. *Rimisp*, 4-7.

Santos-Antonio, G., Bravo-Rebatta, F., Velarde-Delgado, P., & Aramburu, A. (2019a). Effects of front nutrition labeling of foods and beverages: synopsis of systematic reviews. *Pan American Journal of Public Health*, *43*. https://doi.org/10.26633/RPSP.2019.62

Santos-Antonio, G., Bravo-Rebatta, F., Velarde-Delgado, P., & Aramburu, A. (2019b). Effects of front-of-package nutritional labeling of food and beverages: synopsis of systematic reviewsEfeitos dA rotulagem nutricional frontal de alimentos E bebidas: sumário de estudos de revisão sistemática. *Revista Panamericana de Salud Publica= Pan American Journal of Public Health*, *43*, e62-e62. https://pubmed.ncbi.nlm.nih.gov/31456819/

Shahjahan, R. A., Estera, A. L., Surla, K. L., & Edwards, K. T. (2022). "Decolonizing" Curriculum and Pedagogy: A Comparative Review Across Disciplines and Global Higher Education Contexts. In *Review of Educational Research* (Vol. 92, Issue 1). https://doi.org/10.3102/00346543211042423. https://doi.org/10.3102/00346543211042423.

Sillero Rejón, C. (2020). *Social marketing through packaging: Investigating the effects of alcohol and tobacco labeling on visual attention, reactions and attitudes*. (Tesis Doctoral, Universidad de Granada). http://hdl.handle.net/10481/59853

Tello, G. C., Torres, C. O., Ayala, J. L., & Ortiz, P. (2021). Nutritional labeling of processed foods (nutritional traffic light) and its relationship with socioeconomic, cultural, demographic and advertising factors, according to parents of children aged 5-11 years from two schools in Quito: Original Article. *Revista Ecuatoriana de Pediatría*, *22*(3), 21-22. https://doi.org/10.52011/133

Tituaña Puente, A. C. (2019). *Evaluation of the potential use of the colorant extracted from avocado (Persea americana) seed as a functional food product*. Quito.

Torres, I. E. G., Guerra, J. I. G., & Pinos, I. M. L. (2023). Digital educational guide of "Healthy Eating" for consumption habits in students of the Business Administration Career-ESPOCH. *Revista Imaginario Social*, *6*(1). http://revista-imaginariosocial.com/index.php/es/index

Trejo, C. E. A., Cisneros, J. T. C., & Babici, V. R. (2018). Protecting quality of life rights for older adults. Posorja and Puna communities. *Persona y Bioética*, *22*(1), 90-102.

Trejo Osti, L. E., Ramírez Moreno, E., & Ruvalcaba Ledezma, J. C. (2021). Effect of frontal warning labeling of food and beverages. The experience of other Latin American countries. *Journal of Negative and No Positive Results*, *6*(7), 977-990. https://dx.doi.org/10.19230/jonnpr.4176

Triptolemos, F. (2022). REPORT on front-of-food labeling: nutritional traffic lights, "Nutri-Score" and others. *ACTA-CL*, *76*, 5-13. https://agricultura.gencat.cat/web/.content/de_departament/de10_publicacions_dar/de10_b03_alimentacio-comunicacio/documents/fitxers-binaris/05-AyC-es.pdf

Waterfield, G., Kaplan, S., & Zilberman, D. (2020). Willingness to pay versus willingness to vote: consumer and voter avoidance of genetically modified foods. *American Journal of Agricultural Economics*, *102*(2), 505-524. https://doi.org/10.1002/ajae.12001

Young, G., & AS Householder (1938). Discussion of a set of points in terms of their mutual distances. *Springer.* https://idp.springer.com/authorize/casa?redirect_uri=https://link.springer.com/article/10.1007/BF02287916&casa_token=YNp660BgRXQAAAAA:lNj7uMMvU-

KO9vOM99RABUba1niuRst88D87IRnxVLzhqXBk4iTWin6v0IGN7PkyqJgZDSK0QErZRdkQ