SCIENTIA PLENA
www.scientiaplena.org.br
VOL. 22, NUM. 04 2026
doi: 10.14808/sci.plena.2026.041501

Influence of sensory and non-sensory factors on the acceptance and preference for protein food bars at different costs

Influência de fatores sensoriais e não sensoriais na aceitação e preferência por barras alimentícias proteicas em diferentes custos

A. P. A. Mendes[1]; R. C. Pereira[1,2]; J. D. S. Carneiro[3]; J. P. L. de Oliveira[1*]; M. C. de Angelis-Pereira[1]

[1]*Department of Nutrition, Federal University of Lavras, 37200-900, Lavras-MG, Brazil*
[2]*Department of Agrarian Science, Federal Institute of Minas Gerais,38900-000, Bambuí-MG, Brazil*
[3]*Department of Food Science, Federal University of Lavras, 37200-900, Lavras-MG, Brazil*

**joaopaulolimanut@gmail.com*
(Recebido em 23 de janeiro de 2026; aceito em 19 de março de 2026)

This study aimed to evaluate the influence of non-sensory information (nutritional value, ingredient list, and price) and consumer-related factors (purchase determinants, lifestyle, dietary habits, and label-reading practices) on the acceptance and preference of two newly developed protein bars. Participants were previously screened for self-reported food allergies. Two acceptance tests were conducted: one without product information (n = 104) and another including information on nutritional value, price, and ingredients (n = 100). Acceptance was assessed using a nine-point hedonic scale. Additionally, a questionnaire was applied to investigate lifestyle characteristics, the perceived importance of non-sensory attributes in food choices, and label-reading habits. Both products were well accepted, with no significant differences between samples. Sensory attributes were the primary drivers of acceptance under both conditions. Cluster analysis revealed that health-oriented consumers differed in their underlying reasons for product preference. Although price influenced preference across consumer segments, it did not significantly affect acceptance scores. Overall, the findings support the development of nutritionally balanced and affordable protein bars, highlighting the importance of combining sensory quality with strategically communicated non-sensory information to enhance consumer perception and market potential of functional food innovations.
Keywords: acceptance test, nutritional information, consumer segmentation.

Este estudo teve como objetivo avaliar a influência de informações não sensoriais (valor nutricional, lista de ingredientes e preço) e do comportamento do consumidor (determinantes de compra, estilo de vida, hábitos alimentares e leitura de rótulos) na aceitação e preferência por duas barras proteicas recém-desenvolvidas. Os participantes foram previamente triados quanto à presença de alergias alimentares autorreferidas. Foram realizados dois testes de aceitação: um sem informações sobre as amostras (n = 104) e outro com informações sobre valor nutricional, preço e ingredientes (n = 100). A aceitação foi avaliada por meio de escala hedônica de nove pontos. Um questionário adicional investigou estilo de vida, importância das informações não sensoriais e leitura de rótulos. As barras apresentaram boa aceitação, sem diferenças significativas entre as amostras. Os atributos sensoriais foram os principais determinantes da aceitação em ambas as condições. A análise de clusters indicou que consumidores preocupados com a saúde diferiram quanto às razões de preferência entre as barras. Embora o preço tenha influenciado a preferência, não impactou significativamente as notas de aceitação. Os resultados apoiam o desenvolvimento de barras proteicas nutritivas e acessíveis, destacando o papel da qualidade sensorial aliada a informações não sensoriais na percepção do consumidor e no potencial de mercado de alimentos funcionais.
Palavras-chave: teste de aceitação, informação nutricional, segmentação de consumidores.

1. INTRODUCTION

Given the increased awareness of the population regarding the protective role of a healthy diet, the search for nutritionally healthy snacks has increased in recent decades [1, 2]. Among these products are food bars, which are highly sought after by consumers due to their practicality and the nutritional quality they can present, based on the ingredients used in their formulation [3]. Food bars represent a segment of the food industry that grows by approximately 2% annually

worldwide [4, 5]. In Brazil, this growth reached 7.5% between 2013 and 2014, highlighting food bars as products focused on convenience and health-related attributes [4].

The progressive increase in urbanization, changes in lifestyle, long working hours, and shifts in eating habits have led to the replacement of traditional home-cooked meals with quick, and ready-to-eat foods. In this context, can be cited protein bars are considered convenient snacks that promote satiety, support muscle mass gain, and help meet individuals' protein requirements [6]. Protein bars have gained increasing popularity, partly due to the recognized role of dietary protein in appetite regulation, satiety, and weight management. Additionally, consumer studies indicate growing interest in protein fortification of cereal and fruit bars, which may increase their purchase intention and reflects an emerging market trend in this product category [7]. However, developing nutritionally balanced products, free of synthetic additives and with good sensory acceptability and whilst combining practicality, convenience and low cost is a challenge of food science and nutrition research.

The acceptance of a food product goes far beyond the sensory aspects intrinsic to the food. Studies have shown that non-sensory or extrinsic factors, such as sociodemographic characteristics, brand, marketing strategies, and cultural and social factors, influence consumer buying and consumption behavior [8-10]. In addition, label information, such as nutritional information, nutritional and health claims and other marketing strategies adopted by the industry, also exerts a strong influence on the perception and acceptance of and intention to purchase a product [11, 12].

These factors directly influence the expectations created by the consumer about a product; thus, the greater is the expectation created by the consumer, the greater is the probability of opting for the purchase and/or consumption of the product [13].

Previous studies have identified the influence of these factors on different products. In functional yogurts, for example, price, brand and health claims exerted a strong influence on consumer choice [14]. For iced coffee, price, type of coffee, caloric value and country of origin were the factors that most influenced consumer choice [15]. Romano et al. (2015) [16] in turn, showed that for fruit juice obtained by a new processing technology (high hydrostatic pressure), factors such as information on the beneficial effects of the product due to the presence of antioxidants and the use of processing technology to help preserve nutritional value and sensory characteristics were perceived as positive, increasing consumer acceptance and purchase intention.

The present study aimed to evaluate the sensory acceptance of two nutritionally balanced protein bars made from raw materials of different costs (high-cost bar – HC and low-cost bar – LC) and investigate the influence of non-sensory information (nutritional value, list of ingredients, and price) and consumer purchasing behavior (determinants of purchase, lifestyle, food consumption habits, and label reading) on the acceptance and preference for these bars.

2. MATERIALS AND METHODS

2.1 Preparation of the protein bars

Two protein bars (LC and HC) were formulated and produced as previously described in Mendes et al. (2022) [17]. The main difference between the HC and LC bars was in their ingredients. The HC bar included dried cranberry, dried apricot, and almonds, whereas the LC bar contained dried black plum, raisins, and roasted peanuts (Figure 1). Both bars were served in equal portions of 34 g to avoid any potential bias in the sensory evaluation.

SAMPLE A

Nutritional information
Portion of 34 g (1 bar)

Amount per serving		% DV (*)
Energetic value	89kcal = 372 KJ	5%
Carbohydrates	10,4g	5%
Proteins	7,0g	10%
Total fat	2,1g	4%
Saturated fat	0,3g	1%
Trans fat	0g	**
Dietary fiber	6,6g	10%
Sodium	0,24mg	0%

* % Daily Reference Values based on a 2000kcal or 8400K diet.
** Daily values not established

Ingredients

Dehydrated cranberry, whey protein concentrate (80%), dehydrated apricot, roasted almonds, skimmed milk powder, fine oat flakes, chia, dehydrated date and pure cocoa poder.

PRICE: US$ 0,36

SAMPLE B

Nutritional information
Portion of 34 g (1 bar)

Amount per serving		% DV (*)
Energetic value	88kcal = 397KJ	5%
Carbohydrates	10,1	4%
Proteins	7,4	10%
Total fat	1,9	3%
Saturated fat	0,5	2%
Trans fat	0	**
Dietary fiber	5,6	10%
Sodium	0,20mg	0%

* % Daily Reference Values based on a 2000kcal or 8400K diet.
** Daily values not established

Ingredients

Dehydrated black plum, whey protein concentrate (80%), raisins, roasted peanuts, skimmed milk powder, fine oat flakes, brown flax seed, dehydrated date and pure cocoa powder.

PRICE: US$ 0,17

Figure 1: Cards that accompanied the samples of high-cost (Sample A) and low-cost (Sample B) protein bars.

2.2. Sensory acceptance test without information – Stage 1

To evaluate the sensory acceptance of the LC and HC bars, a sensory acceptance test was performed in the Laboratory of Sensory Analysis of the Department of Food Science - UFLA, Brazil, which met the standard requirements [18] to best control and standardize environment conditions for sensory evaluation. This study was approved by the Human Research Ethics Committee (COEP, for its abbreviation in Portuguese) of the Federal University of Lavras (UFLA), according to CAAE registration number 54726716.0.0000.5148, ruling no. 1,563,498.

A total of 104 untrained assessors, who regularly consumed food bars, participated in the sensory evaluation. The assessors were recruited from among university staff as well as undergraduate and graduate students, representing typical consumers of this type of product. Prior to the sensory evaluation, all participants were informed about the study procedures and were asked to read and sign an informed consent form. The informed consent form explicitly stated the presence of potential allergenic ingredients in the samples, including milk (whey protein concentrate and skimmed milk powder), tree nuts (almonds), peanuts, and oats (with possible gluten cross-contamination). Only individuals who declared no known allergies to these ingredients were eligible to sign the consent form and participate in the study.

The test followed the general guidance for sensory analysis ISO 6658 [19]. The two samples were coded with three random numbers. A portion of 10g of each bar (approximately one third of the bar originally prepared) was served in balanced order and monadically, in plastic containers free of odors. Along with the samples, water was served for the tasters to clean their palate between the samples. The tests were performed in individual booths under white light.

The volunteers evaluated the coded samples for acceptance regarding the sensory attributes aroma, appearance, flavor and texture. The acceptance of the samples in terms of overall impression was also evaluated. For this, the nine-point structured hedonic scale described by Stone and Sidel (2003) [20] was used. The scale varied from disliked extremely (1) to liked very much (9), with the neutral point neither liked nor disliked (5).

2.3. Influence of non-sensory variables and consumer purchasing behavior – Stage 2

To evaluate the influence of external information (nutritional value, list of ingredients and price) on the sensory acceptance of protein bars and habits and behaviors during food purchase and consumption, another sensory analysis session was performed seven days after the sensory acceptance test without information. The same procedures described above for sample preparation and storage of samples were followed in this stage.

The test was performed under the same conditions as the acceptance test without information with randomly chosen untrained assessors (not necessarily the same who participated previously). In addition to the samples, the tasters also received, for each bar, a card with the following information: nutritional value, list of ingredients and price of each bar (Figure 1). They were identified with the same code assigned to the sample to which the information referred. The information provided for each sample was assigned a unique code corresponding to that sample, ensuring accurate data recording. This code was not related to any previous blind test and served solely to identify the sample. Therefore, even if the same evaluator participated in multiple sessions, their repeated presence did not influence their choices beyond the information provided for each specific sample.

The participants were instructed that, after reading the information and sampling the samples, they should evaluate the sensory attributes aroma, appearance, flavor and texture and their overall impression using the nine-point structured hedonic scale described by Stone and Sidel (2003) [20]. The scale varied from disliked extremely (1) to liked very much (9), with the neutral point neither liked nor disliked (5).

At this stage, the tasters should also indicate, by selecting in the evaluation form, the code for the preferred sample, plus the degree of importance of the sensory aspects, ingredients, nutritional value and price in the choice of the preferred bar using a five-point importance scale that ranged from “not very important” (score 1) to “very important” (score 5).

Finally, the tasters received a structured questionnaire designed to assess lifestyle characteristics, general food purchasing and consumption behaviors, and self-reported reasons for choosing food bars in general, using a 5-point importance scale ranging from ‘not important’ (score 1) to ‘very important’ (score 5). The habit of reading nutritional information and nutrition and health claims on food labels was assessed by the frequency of reading this information, using a 5-point scale ranging from ‘never’ (score 1) to ‘always’ (score 5).

2.4. Statistical analyses

The data from the acceptance tests without information and with information were compared by independent t-test to identify possible differences between the mean scores given for each attribute for each bar in both sessions (informed and not informed). The significance level was defined as $p < 0.05$. Internal preference maps with the sensory attributes evaluated were generated for the acceptance tests with and without information. RStudio software (RStudio, Inc. Version 1.1.463, Boston, MA, USA) was used for this analysis.

The data from the preference test and the questionnaire on habits and behaviors during food purchase and consumption were used for the segmentation of consumers through cluster analysis. This analysis sought to identify possible differences between the groups regarding the preference for high- and low-cost bars, considering the subjective responses of each consumer.

The analysis included the following steps: hierarchical segmentation analysis using the sociodemographic variables gender, age, income and education level (stage I); k-means procedure for the centroids of the hierarchical clusters to identify 2-3 clusters (stage II). The 2-cluster solution was selected as the most appropriate for discussion because it showed the highest correlation between the members obtained by hierarchical segmentation and k-means. SPSS Statistics software (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY, USA) was used for this analysis.

The profile of these clusters was defined by a sequence of cross-correlation analyses with the results of the preference test and the questionnaire on habits and behaviors during food purchase and consumption. The significance of these associations was determined by the chi-squared test,

with a significance level of $p<0.05$. SPSS Statistics software (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY, USA) was used for this analysis.

3. RESULTS

In the sensory acceptance test without information, 104 volunteers participated, 64 females and 40 males, with a mean age of 22 years, mostly undergraduate students. For the sensory acceptance test with information, 100 volunteers participated, 60 female and 40 male, with a mean age of 23 years, mostly undergraduate students.

The mean scores obtained for each of the sensory attributes and for the overall impression of the samples of LC and HC bars without information and with information (nutritional composition, list of ingredients and price) are shown in Table 1.

Table 1: Means of the scores obtained for the sensory attributes and overall impression of high-cost (HC) and low-cost (LC) protein food bars

	Test without information (n = 100)		**Test with information (n = 104)**	
Attribute	**HC**	**LC**	**HC**	**LC**
Appearance	6.84	7.11	7.24	7.07
Aroma	7.64*	6.84*	7.16	7.55
Texture	7.29	7.44	7.37	7.28
Flavor	7.33	7.01	7.34	7.29
Overall impression	7.32	7.22	7.40	7.41

HC: High-cost bar; LC: Low-cost bar

* Statistically different means ($p < 0.05$) by independent t-test.

The two formulations presented very similar nutritional profiles, with only minor differences in macronutrient composition. HC showed slightly higher carbohydrate (10.4 g), total fat (2.1 g), and dietary fiber (6.6 g) contents, whereas LC exhibited a marginally higher protein content (7.4 g) compared with HC (7.0 g). Energy values were nearly identical between the samples, corresponding to 89 kcal for HC and 88 kcal for LC per 34 g portion. Despite the similar nutritional composition, the production cost differed considerably, with HC costing US$0.36 per unit and LC US$0.17, reflecting differences in ingredient composition (Figure 1).

In the test conducted without information, the LC and HC bars received statistically similar scores for all evaluated attributes, except for aroma, for which the HC bar presented a higher mean score (7.64) compared to the LC bar (6.84). Both formulations achieved mean overall impression scores above 7.0, indicating good sensory acceptance. These results suggest that the replacement of high-cost ingredients with lower-cost alternatives, when not disclosed to consumers, did not negatively affect sensory acceptance.

The same trend was maintained in the sensory acceptance test with information; that is, both bars were well accepted, and the presence of the nutritional table, list of ingredients and price did not significantly alter the acceptance of either bar.

When comparing the scores obtained for each bar in both tests, there was no significant difference between the means obtained; that is, the external information evaluated did not influence the score assigned to sensory aspects and overall impression and, consequently, in the sensory acceptance of the bars.

The internal preference maps for the test without information (Figure 2A) and with information (Figure 2B) reinforce these results. Because there was a homogeneous distribution of consumers, this distribution was close to the vectors (attributes), which indicates that there was acceptance of the bars by the consumers in both situations, reinforcing the evidence that the acceptance was not altered when the consumers tasted the samples and had information regarding the nutritional composition, ingredients and price. The components explained 75.91% and 71.87% of the data variability in the tests without and with information, respectively.

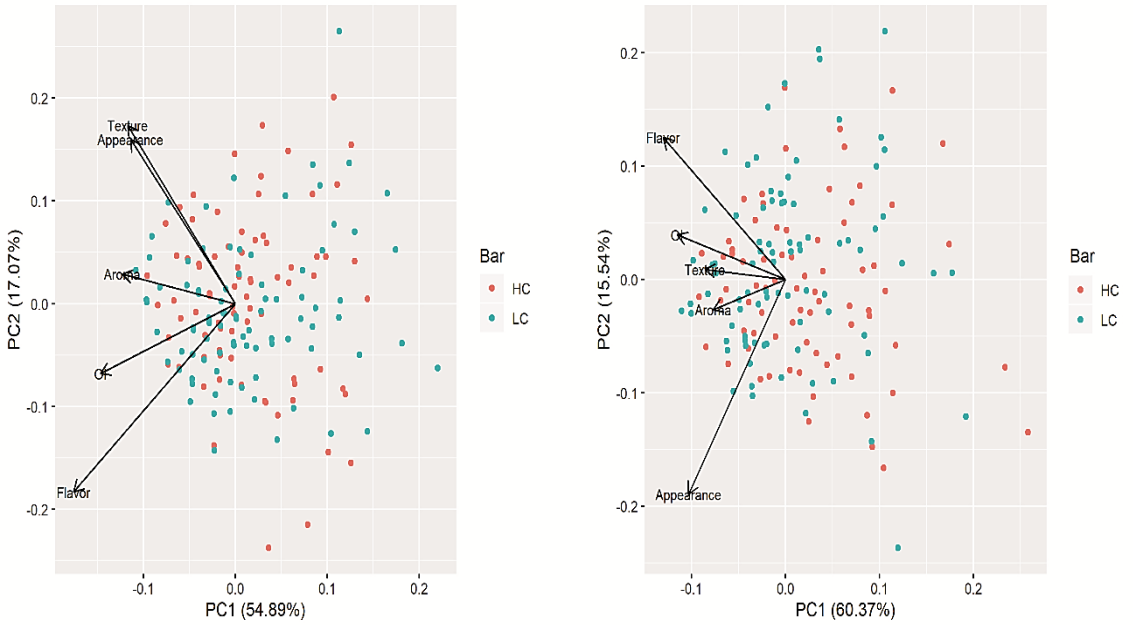

Figure 2: Internal preference map of the acceptance scores for each of the attributes tested in the sensory analysis of low-cost (LC) and high-cost (HC) protein bars: test without information (A) and test with information (B).

Preference data collected in the test with information indicated no significant association between the preferred sample (LC or HC bar) and the formulations evaluated (χ^2 test; $p = 0.150$). While 50.96% of the participants indicated preference for the LC bar, 49.04% preferred the HC bar.

Through the segmentation of consumers, two clusters were obtained regarding the frequency of physical activity, consumption of fruits and vegetables, and frequency of reading of the nutritional table, nutritional claims and health claims (Table 2) and regarding the degree of importance regarding the reasons for bar choice (Table 3).

From this segmentation, it was evident that the eating habits and behaviors of purchase and consumption were variable between the two clusters. Thus, cluster 1 was named “Healthier” because it included consumers more concerned with health (higher frequency of physical activity and more frequent consumption of fruits and vegetables) and with the nutritional composition of the foods they buy and consume (higher frequency of reading the information provided on the label) ($p < 0.05$; Table 2). This cluster was also characterized by a higher proportion of consumers who considered the nutritional value of food to be important or very important at the time of purchase of food bars ($p < 0.05$; Table 2). Cluster 2, on the other hand, named “Less Healthy”, included consumers less concerned with health and the nutritional composition of the food they buy and consume (Table 2; Table 3).

Table 2: Characterization of the tasters regarding lifestyle and eating habits for the different clusters.

Variable		p *	Cluster 1 "Healthier" (n = 31)		Cluster 2 "Less Healthy" (n = 72)	
			n	%	n	%
Frequency of physical activity		0.019				
	every day		3	**9.68**	4	5.56
	6× per week		4	**12.90**	2	2.78
	5× per week		3	**9.68**	5	6.94
	4× per week		6	**19.35**	4	5.56
	3× per week		6	**19.35**	7	9.72
	2× per week		3	9.68	13	**18.06**
	1× per week		1	3.23	4	**5.56**
	<1× per week		5	16.13	33	**45.83**
Consumption of fruit		<0.001				
	4× per day or more		**5**	**16.13**	1	1.40
	3× per day		**11**	**35.48**	4	5.60
	2× per day		**10**	**32.26**	15	20.80
	1× per day		4	12.90	**29**	**40.30**
	<1× per day		1	3.23	**20**	**27.80**
	does not consume		0	0.00	**3**	**4.20**
Consumption of vegetables		0.002				
	4× per day or more		**3**	**9.68**	0	0.00
	3× per day		**1**	**3.23**	2	2.80
	2× per day		**20**	**64.52**	26	36.10
	1× per day		6	19.35	**37**	**51.40**
	<1× per day		1	3.23	**7**	**9.70**
	does not consume		0	0.00	**0**	**0.00**
Reading the nutritional table		<0.001				
	always reads		**16**	**51.61**	8	11.10
	often reads		**12**	**38.71**	19	26.40
	sometimes reads		3	9.68	**20**	**27.80**
	rarely reads		0	0.00	**18**	**25.00**
	does not read		0	0.00	**7**	**9.70**
Reading of nutritional claims		<0.001				
	always reads		**19**	**61.29**	7	9.70
	often reads		**11**	**35.48**	14	19.40
	sometimes reads		1	3.23	**32**	**44.40**
	rarely reads		0	0.00	**16**	**22.20**
	does not read		0	0.00	**3**	**4.20**
Reading of health claims		<0.001				
	always reads		**16**	**51.61**	1	1.40
	often reads		**11**	**35.48**	10	13.90
	sometimes reads		2	6.45	**27**	**37.50**
	rarely reads		2	6.45	**25**	**34.70**
	does not read		0	0.00	**9**	**12.50**

* Significant differences according to the chi-squared test, $p < 0.05$.

Table 3: Degree of importance regarding the reasons for bar choice for the different clusters.

Variable		**p ***	**Cluster 1 "Healthier" (n = 31)**		**Cluster 2 "Less Healthy" (n = 72)**	
			n	**%**	**n**	**%**
Nutritional value		**0.002**				
	Not very important		0	0.00	1	1.39
	Slightly important		0	0.00	11	**15.28**
	Indifferent		0	0.00	15	**20.83**
	Important		**11**	**35.48**	**22**	**30.56**
	Very important		**20**	**64.52**	**23**	**31.94**
Flavor		0.533				
	Not very important		0	0.00	0	0.00
	Slightly important		1	3.23	1	1.39
	Indifferent		1	3.23	2	2.78
	Important		12	38.71	19	26.39
	Very important		17	54.84	50	69.44
Practicality		0.556				
	Not very important		0	0.00	1	1.39
	Slightly important		1	3.23	4	5.56
	Indifferent		3	9.68	11	15.28
	Important		12	38.71	33	45.83
	Very important		15	48.39	23	31.94
Price		0.155				
	Not very important		0	0.00	2	2.78
	Slightly important		0	0.00	5	6.94
	Indifferent		2	6.45	7	9.72
	Important		10	32.26	31	43.06
	Very important		19	61.29	27	37.50
List of ingredients		0.391				
	Not very important		1	3.23	1	1.39
	Slightly important		2	6.45	6	8.33
	Indifferent		4	12.90	9	12.50
	Important		9	29.03	34	47.22
	Very important		15	48.39	22	30.56

*Significant differences according to the chi-squared test, $p < 0.05$.

With this segmentation, the degree of importance regarding the reasons for choosing the preferred bar (LC or HC) was evaluated (Table 4). These data showed that the list of ingredients and the nutritional value of the bar were factors considered important or very important for the choice of one of the bars by consumers in cluster 1 ("Healthier") ($p < 0.05$). This degree of importance was not perceived to the same degree by cluster 2 consumers ("Less Healthy"). However, these factors did not impact the preference for the LC or HC bar.

Table 4: Degree of importance regarding the reasons for choosing the preferred bar (high cost or low cost) for the different clusters.

Variable		p *	Cluster 1 Healthier (n = 31)		Cluster 2 Less Healthy (n = 72)	
			n	%	n	%
Sensory aspects		0.086				
	Not very important		1	3.23	0	0.00
	Slightly important		2	6.45	1	1.39
	Indifferent		2	6.45	1	1.39
	Important		7	22.58	29	40.28
	Very important		19	61.29	41	56.94
List of ingredients		**0.001**				
	Not very important		0	0.00	2	2.78
	Slightly important		0	0.00	8	11.11
	Indifferent		2	6.45	12	16.67
	Important		**10**	**32.26**	**35**	**48.61**
	Very important		**19**	**61.29**	**15**	**20.83**
Nutritional value		**0.002**				
	Not very important		0	0.00	0	0.00
	Slightly important		0	0.00	8	11.11
	Indifferent		1	3.23	19	26.39
	Important		**11**	**35.48**	**24**	**33.33**
	Very important		**19**	**61.29**	**21**	**29.17**
Price		0.391				
	Not very important		1	3.23	1	1.39
	Slightly important		2	6.45	6	8.33
	Indifferent		4	12.90	9	12.50
	Important		9	29.03	34	47.22
	Very important		15	48.39	22	30.56

*Significant differences according to the chi-squared test, $p < 0.05$.

4. DISCUSSION

Although the reasons underlying the preference for one of the bars (LC or HC) differed between the two consumer segments, the preferences were similar regardless of the available information on nutritional content, ingredients, or price. The consumer segments were defined based on their responses to questions regarding dietary habits, allowing classification into healthier and less health groups. This reinforces the evidence that, for the protein bars developed in the present study, sensory attributes were the primary determinant of acceptance, regardless of composition, nutritional value, or price. In this context, it is important to highlight that the effectiveness of label claims is moderated by factors such as nutritional knowledge, health promotion orientation, and compensatory health beliefs. For instance, individuals with greater health consciousness tend to be more influenced by nutritional claims, whereas those with more advanced nutritional knowledge may exhibit greater skepticism toward such information [21]. Moreover, price plays a significant role in the purchase of food bars, posing a considerable challenge for the food industry in setting affordable prices aligned with portion sizes and in promoting increased consumption of nut-based, protein-enriched, and high-energy bars [22]. It is noteworthy that, in the sensory test conducted without product information, a statistically significant difference was observed for aroma, with the HC bar receiving a higher score. The HC formulation included cranberry and apricot, which may explain the superior aroma due to the presence of volatile compounds. Aroma is associated with a wide variety of low-molecular-weight volatile compounds [23]. The composition of volatile compounds determines the characteristic aromatic profile of each fruit, enabling differentiation not only among distinct species but also among varieties within the same species, whose qualitative and quantitative variations may influence consumer preference [24].

This result corroborates those reported by Estima et al. (2009) [25] in a literature review on the determinant factors of food consumption; the authors found that taste and other sensory aspects are the main factors that drive the choice of humans for food, regardless of their economic condition, being one of the least negotiable factors in the choice and purchase of food.

Notably, however, the group of tasters in the present study was mostly characterized by young university students, which may have contributed to these results. It should be noted that, although the tasters in Stage 2 were not necessarily the same individuals as in Stage 1, this is unlikely to have introduced significant interpersonal bias. The participants were university students with similar age ranges and dietary habits, characterized by frequent consumption of industrialized foods and convenience snacks, such as cereal and protein bars. Consequently, despite minor changes in panel composition, the sample remained relatively homogeneous, supporting the robustness and validity of the observed results. Notably, information such as nutritional value and nutritional and health claims can help the population choose healthy and adequate foods, they were not important enough to impact the choice of products. This fact is often justified by the lack of understanding on the part of consumers of how to use this information, or, especially in the case of young people, by not being concerned about the damage to health associated with poor diet, because they believe they are immune to these issues due to the simple fact that they are young. Although young consumers have traditionally been described as less concerned about the long-term risks associated with poor dietary habits and less likely to consult nutrition labels, this pattern appears to be evolving. A study conducted with 361 Peruvian university students highlighted the strong influence of sensory appeal on food preferences, indicating that sensory stimuli may take precedence over health-related concerns in the decision-making process. At the same time, the findings demonstrated that health consciousness and a positive perception of front-of-pack nutritional labeling function as important protective factors, potentially discouraging the purchase of unhealthy foods [26]. The study by Missagia et al. (2017) [27], which evaluated motivations for food choice, reinforces that the majority of the assessed sample exhibited high concern for the nutritional characteristics of foods, showing greater sensitivity to nutritional quality and health benefits compared to the other groups, while also valuing both the sensory pleasure during consumption and the nutritional aspects of foods. However, it is important to emphasize that sociodemographic variables such as gender, age, income, and educational level influence patterns and behaviors related to the consumption of food bars. Therefore, implementing educational strategies aimed at consumers is essential to improve their understanding of label information and its impact on making healthier food choices [28].

In fact, young groups are less influenced by nutritional information because they do not have enough maturity to change their actions in the face of this information and because they consider themselves less susceptible to diet-related health problems [29].

Bendino et al. (2012) [30] evaluated the importance that consumers attributed to information on labels, including nutritional information, and found that 76% of consumers did not consider it important to read nutritional information, and more than half said they would not stop buying food after reading the nutritional information. The items sodium and dietary fiber were cited as the least important.

In addition to nutritional composition, nutrition and health claims have the potential to significantly influence consumer behavior toward healthier food choices. While nutrition science provides the foundation for public health initiatives and informs the formulation of nutrition and health claims, effectively guiding consumer choices may also require a more nuanced understanding of how individuals perceive nutrition and engage with food in their daily lives [31]. However, nutrition and health claims are not yet exploited by most consumers.

Cavaliere et al. (2015) [32] evaluated the profile of consumers interested in nutritional and health claims. It was found that nutritional claims are more valued by women, families with small children and those who have greater nutritional knowledge. For the health claims, it was observed that they are of greater interest to the elderly, probably because they recognize their greater vulnerability.

In the study cited above, it was also found that the interest in health claims by young people was lower than the interest in nutritional claims, which is probably associated with worse

perception of diet-related health risks. This result agrees with the present study because reading health claims was restricted to 8% of the volunteers.

The analysis of Cluster 1 indicates that, for the healthier group, the ingredient list and nutritional value were decisive variables in the selection of the preferred protein bar. This finding suggests a more deliberate and information-driven decision-making pattern, in which nutritional attributes and formulation transparency play a central role in consumer preference. This behavior is consistent with current trends in the cereal bar industry, whose future is increasingly associated with the development of formulations with high nutritional value, without compromising sensory attributes or product quality, while also enhancing naturalness and sustainability [33]. In this context, cereal bars represent portable food products that can function as meal replacements, supplements, or snacks, meeting contemporary consumer demands for convenience, healthfulness, and practicality [33]. It is important to highlight that generational differences can influence food choices and, consequently, consumer preferences for cereal or protein bars. Younger consumers often prioritize convenience, sensory appeal, and products aligned with their lifestyle, such as protein bars associated with physical activity or cereal bars with sweeter flavor profiles. Chen et al. (2024) [34] highlights differences in food choice behavior between Generation Z and Generation Y, showing that while both groups consider factors such as health, convenience, price, and word of mouth, convenience tends to be more important for Gen Z, whereas price plays a more decisive role for Gen Y. A study conducted with the Chinese population identified clear generational differences in dietary patterns. Younger adults showed lower consumption of cereals and vegetables and lower total energy intake compared with older generations, while presenting higher intake of animal-based foods, fruit, and dairy products, as well as a greater contribution of protein and fat to total energy intake [35].

Thus, it is necessary to work on improving the understanding and the recognition of the importance of nutritional information, as well as nutritional and health claims, as auxiliary tools in the choice of healthier foods. Therefore, actions involving food and nutrition education with children, adolescents and adults in schools, in public institutions and in the media represent opportunities for healthier choices, which will contribute to a better quality of diet and, in the future, lead to a reduction in the incidence of obesity and noncommunicable diseases.

Despite the relevance of the findings, some limitations should be acknowledged. The evaluated food bars differed not only in the price information provided to consumers but also in their formulations, which may have influenced sensory perception and acceptance. As sensory attributes are known to be decisive factors in food choice, especially among young consumers, these differences may have limited the ability to isolate the specific effect of price and label information on product acceptance. Additionally, the predominance of young university students among the assessors may restrict the generalizability of the results to other population groups. Future studies should seek to control product formulation while independently manipulating price and labeling information, as well as include more diverse consumer profiles, in order to better understand the relative contribution of these factors to food choice.

5. CONCLUSION

The developed protein bars with different costs were sensorially accepted by consumers. Sensory factors were the determining factors for acceptance, both in the test without information and in the test with information regarding nutritional composition, ingredients and price. The preference was also not different in light of this information.

The segmentation of consumers into two clusters indicated, however, that the reasons for choosing one of the bars as preferred were different for the group of consumers more concerned with health, that is, those who had healthier lifestyle habits and were more concerned with the food they buy and consume. For them, the reasons for choice and intention were justified by the nutritional information and the ingredients of the bars, which was not as evident for the second group of consumers who were not as concerned with health.

Although price was considered an important or very important factor for preference in both segments, it did not influence acceptance scores or the preference for either bar.

Together, these results demonstrate the feasibility of developing protein bars based on healthy ingredients, combining practicality, convenience and low cost, that are an accessible option for the low-income population and an alternative to encourage the reduction in the consumption of ultra-processed foods.

6. ACKNOWLEDGEMENTS

The authors would like to thank Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG - project code CAG-APQ-00798-16), and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the financial support. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

7. REFERENCES

1. Gomes KS, Berwian GF, Batistella VMC, Bender LE, Reinehr CO, Colla LM. Nutritional and technological aspects of the production of proteic extruded snacks added of novel raw materials. Food Bioproc Tech. 2023;16:247-67. doi: 10.1007/s11947-022-02887-0
2. Schlinkert C, Gillebaart M, Benjamins J, Poelman M, de Ridder D. The snack that has it all: People's associations with ideal snacks. Appetite. 2020;152:104722. doi: 10.1016/j.appet.2020.104722
3. Appelt P, da Cunha MAA, Guerra AP, Kalinke C, de Lima VA. Development and characterization of cereal bars made with flour of jabuticaba peel and okara. Acta Sci Technol. 2015;37:117. doi: 10.4025/actascitechnol.v37i1.21070
4. Pinto VRA, Freitas TBO, Dantas MIS, Della Lucia SM, Melo LF, Minim VPR, et al. Influence of package and health-related claims on perception and sensory acceptability of snack bars. Food Res Int. 2017;101:103-13. doi: 10.1016/j.foodres.2017.08.062
5. Bevenuto Mattar J, Carare Candido A, Larissa de Souza Vilela D, Ladeira de Paula V, Carla Vidigal Castro L. Information displayed on Brazilian food bar labels points to the need to reformulate the current food labelling legislation. Food Chem. 2022;370:131318. doi: 10.1016/j.foodchem.2021.131318
6. AlJaloudi R, Al-Dabbas MM, Hamad HJ, Amara RA, Al-Bashabsheh Z, Abughoush M, et al. Development and characterization of high-energy protein bars with enhanced antioxidant, chemical, nutritional, physical, and sensory properties. Foods. 2024;13:259. doi: 10.3390/foods13020259
7. Kosicka-Gębska M, Sajdakowska M, Jeżewska-Zychowicz M, Gębski J, Gutkowska K. Consumer perception of innovative fruit and cereal bars—current and future perspectives. Nutrients. 2024;16:1606. doi: 10.3390/nu16111606
8. Torres-Moreno M, Tarrega A, Torrescasana E, Blanch C. Influence of label information on dark chocolate acceptability. Appetite. 2012;58:665-71. doi: 10.1016/j.appet.2011.12.005
9. Bruce AS, Pruitt SW, Ha O-R, Cherry JBC, Smith TR, Bruce JM, et al. The influence of televised food commercials on children's food choices: Evidence from ventromedial prefrontal cortex activations. J Pediatr. 2016;177:27-32.e1. doi: 10.1016/j.jpeds.2016.06.067
10. Moran AJ, Khandpur N, Polacsek M, Rimm EB. What factors influence ultra-processed food purchases and consumption in households with children? A comparison between participants and non-participants in the Supplemental Nutrition Assistance Program (SNAP). Appetite. 2019;134:1-8. doi: 10.1016/j.appet.2018.12.009
11. Kaur A, Scarborough P, Hieke S, Kusar A, Pravst I, Raats M, et al. The nutritional quality of foods carrying health-related claims in Germany, The Netherlands, Spain, Slovenia and the United Kingdom. Eur J Clin Nutr. 2016;70:1388-95. doi: 10.1038/ejcn.2016.114
12. Oostenbach LH, Slits E, Robinson E, Sacks G. Systematic review of the impact of nutrition claims related to fat, sugar and energy content on food choices and energy intake. BMC Public Health. 2019;19:1296. doi: 10.1186/s12889-019-7622-3
13. Carrillo E, Varela P, Fiszman S. Effects of food package information and sensory characteristics on the perception of healthiness and the acceptability of enriched biscuits. Food Res Int. 2012;48:209-16. doi: 10.1016/j.foodres.2012.03.016
14. Ares G, Giménez A, Deliza R. Influence of three non-sensory factors on consumer choice of functional yogurts over regular ones. Food Qual Prefer. 2010;21:361-7. doi: 10.1016/j.foodqual.2009.09.002
15. Asioli D, Næs T, Granli BS, Lengard Almli V. Consumer preferences for iced coffee determined by conjoint analysis: an exploratory study with Norwegian consumers. Int J Food Sci Technol. 2014;49:1565-71. doi: 10.1111/ijfs.12485

16. Romano KR, Rosenthal A, Deliza R. How do Brazilian consumers perceive a non-traditional and innovative fruit juice? An approach looking at the packaging. Food Res Int. 2015;74:123-30. doi: 10.1016/j.foodres.2015.04.033
17. Mendes APA, Bemfeito CM, Pereira RC, de Sousa Cândido G, de Deus Souza Carneiro J, de Barros Vilas Boas EV, et al. Economic versus nutritional viability: evaluation of the antioxidant potential of food bars sources of proteins of different production costs. J Food Sci Technol. 2022;59:46-54. doi: 10.1007/s13197-021-04977-x
18. ISO - International Organization for Standardization. ISO 8589:2007 Sensory analysis — General guidance for the design of test rooms [Internet]; 2007 [accessed 2025 Jun 10]. Available from: https://www.iso.org/standard/36385.html.
19. ISO - International Organization for Standardization. ISO 6658:2017 Sensory analysis — Methodology — General guidance [Internet]; 2017 [accessed 2025 Jun 10]. Available from: https://www.iso.org/standard/65519.html.
20. Stone H, Sidel JL. Sensory evaluation: descriptive analysis. In: Caballero B, editor. Encyclopedia of food sciences and nutrition. 2nd ed. San Diego (US): Academic Press; 2003. p. 5152-61.
21. Tønnesen MT, Hansen S, Laasholdt AV, Lähteenmäki L. The impact of positive and reduction health claims on consumers' food choices. Food Qual Prefer. 2022;98:104526. doi: 10.1016/j.foodqual.2022.104526
22. Pinto VRA, de Oliveira Freitas TB, Melo LF, de Freitas LS, de Souza Araújo LG, Minim VPR, et al. What grabs our attention most to consume a snack bar in Brazil? Following trends in choice of snack bars to boost market for healthier options. Open Food Sci J. 2018;10:62-78. doi: 10.2174/1874256401810010062
23. Giménez-Sanchis A, Bermejo A, Besada C. Changes in the sugars and volatile compounds profiles associated with anthocyanin accumulation in oranges: blood vs. blond varieties, and slightly pigmented vs. intensely pigmented blood fruit. Food Res Int. 2024;197:115199. doi: 10.1016/j.foodres.2024.115199
24. Freitas TP, Taver IB, Spricigo PC, do Amaral LB, Purgatto E, Jacomino AP. Volatile compounds and physicochemical quality of four jabuticabas (*Plinia* sp.). Molecules. 2020;25:4543. doi: 10.3390/molecules25194543
25. Estima CCP, Philippi ST, Alvarenga MS. Fatores determinantes de consumo alimentar: por que os indivíduos comem o que comem? Rev Bras Nutr Clín. 2009;24:263-8.
26. Saintila J, Florián-Castro RO, Macedo-Barrera EM, Pérez-Facundo RP, Calizaya-Milla YE. Health consciousness, sensory appeal, and perception of front-of-package food labels as predictors of purchase intention for unhealthy foods in Peruvian university students. Nutrients. 2025;17:1921. doi: 10.3390/nu17111921
27. Missagia SV, Oliveira SR, de Rezende DC. Motivações relacionadas à escolha alimentar: segmentação de consumidores. Agroalimentaria. 2017;23(44):107-21.
28. Domiciano CG, Pereira RC, Picinin CTR, Machado FS, de Angelis-Pereira MC. Food bar labels: consumer behaviour and veracity of the available information. Braz J Food Technol. 2017;21:e2016131. doi: 10.1590/1981-6723.13116
29. Endrizzi I, Torri L, Corollaro ML, Demattè ML, Aprea E, Charles M, et al. A conjoint study on apple acceptability: Sensory characteristics and nutritional information. Food Qual Prefer. 2015;40:39-48. doi: 10.1016/j.foodqual.2014.08.007
30. Bendino NI, Popolim WD, Oliveira CRÁ. Avaliação do conhecimento e dificuldades de consumidores frequentadores de supermercado convencional em relação à rotulagem de alimentos e informação nutricional. J Health Sci Inst. 2012;30:261-5.
31. Neale EP, Tapsell LC. Nutrition and health claims: Consumer use and evolving regulation. Curr Nutr Rep. 2022;11:431-6. doi: 10.1007/s13668-022-00422-3
32. Cavaliere A, Ricci EC, Banterle A. Nutrition and health claims: Who is interested? An empirical analysis of consumer preferences in Italy. Food Qual Prefer. 2015;41:44-51. doi: 10.1016/j.foodqual.2014.11.002
33. Boukid F, Klerks M, Pellegrini N, Fogliano V, Sanchez-Siles L, Roman S, et al. Current and emerging trends in cereal snack bars: implications for new product development. Int J Food Sci Nutr. 2022;73:610-29. doi: 10.1080/09637486.2021.2005750
34. Chen J, Xu A, Tang D, Zheng M. Divergence and convergence: a cross-generational study on local food consumption. Sci Rep. 2024;14:13463. doi: 10.1038/s41598-024-64284-134
35. Guo L, Huang F, Liu M, Zhang Y, Zhang J, Zhang B, et al. Generational differences in food consumption among Chinese adults of different ages. Nutrients. 2023;15:4451. doi: 10.3390/nu15204451