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Beyond Taste: Unpacking Consumer Perceptions of Plant-Based Cheese Alternatives in Uruguay Through Sensory, Information, and Expectation Analysis

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Abstract

Plant-based cheese alternatives (PBCAs) are considered sustainable substitutes for dairy-based cheese (DB); however, their consumer acceptance remains limited, particularly in dairy-dominant cultural contexts such as Uruguay, where specific consumer insights are scarce. This study investigated the influence of sensory experience, product information, and conceptual expectations on consumer perceptions of commercially available mozzarella-style PBCAs in Uruguay. Three sessions were conducted: blind and informed tastings (n = 110) and an expectation survey with a separate participant group (n = 236). Liking, purchase intention, and conceptual associations were evaluated using hedonic scales, CATA questions, and cluster analyses. Dairy-based cheese consistently achieved the highest liking and purchase intention scores. Positive sensory drivers for acceptance included a smooth mouthfeel, creaminess, and shiny appearance, whereas artificial flavors and strong aftertastes reduced acceptance. One PBCA showed an acceptable texture but lacked flavor. Crucially, providing product information did not enhance PBCA acceptance, underscoring the importance of sensory experiences. Cluster analysis revealed two consumer segments: "adopters" (n = 176), who are younger, have higher purchase intentions, and associate PBCAs with sustainability; and "non-adopters" (n = 60), who were older and perceived PBCAs as artificial and unappealing. PBCAs hold potential among sustainability-oriented consumers, but improving flavor authenticity and sensory quality is crucial. Addressing these sensory barriers and strategically positioning products around health and environmental benefits are crucial for broadening overall acceptance and facilitating sustainable dietary shifts in the population.

Introduction

Consumer perceptions, beliefs, and values strongly influence the acceptance of plant-based proteins as sustainable and healthy dietary choices [1]. With the increasing adoption of plant-based diets for health and ethical reasons, there is a growing demand for Plant-Based Cheese Alternatives (PBCAs). However, PBCAs are still in the initial phase of consumer adoption[2].

Although PBCAs are becoming more accessible, there is limited understanding of how consumers in Latin America, especially in Uruguay, view these products in terms of their sensory and nutritional attributes and conceptual associations. Despite the increasing exposure of Uruguayan consumers to plant-based foods, research specifically on their acceptance of plant-based cheeses is lacking, particularly in this dairy-dominant cultural context, where cheese has strong traditional and emotional associations. Most existing research originates from developed markets, such as the UK[3, 4], Canada [5], New Zealand [6, 7], the US [8], Spain [9], and Europe[10], where PBCAs often receive lower liking scores than dairy cheeses because of their flavor and texture limitations.

For human well-being, the success of plant-protein alternatives relies on both biological efficiency and social acceptance, with a critical need to address the psychological barriers to consumption. While ingredients or nutritional information can influence expectations, they do not always lead to higher sensory acceptance and may even reduce liking if expectations are not met[11–13]. From a sensory

perspective, texture and flavor remain the primary barriers to acceptance, although visual cues, such as color and meltability, also affect perceived quality[3, 5, 6]. In most cases, PBCAs are prepared using soybeans or coconuts. Consumers find the beany and chalky flavors of soy-derived PBCAs unappealing [14]. A recent study indicated that modified fermentation is a strategy to improve consumer preference by improving the beany and gritty mouthfeel of soy-based cheese [15]. These inherent sensory limitations often lead to varied consumer responses, resulting in different consumer segments. Recent findings from a consumer study with New Zealand consumers led to the formation of two different clusters, with the majority being defined as PBCA Rejectors, based on their strong dislike for the taste of PBCA products, along with their dairy counterparts[16]. Another study on PBCAs reported four clusters that differed in consumer preferences for flavor and texture attributes related to dairy and plant-based cheese alternatives[17].

In summary, while global evidence highlights the sensory, nutritional, and conceptual barriers to PBCA acceptance, there remains a lack of context-specific understanding of how consumers in dairy-oriented cultures, such as Uruguay, evaluate these products under different informational and sensory conditions. Addressing this gap can provide critical insights for developing culturally adapted plant-based innovations and effective market-positioning strategies. In light of the aforementioned facts, the objectives of this study are as follows: First, to assess how nutritional and ingredient information influences the sensory perceptions of plant-based cheese alternatives. Second, the primary sensory factors driving liking or disliking. Third, to categorize consumers based on their purchase intentions and define the unique conceptual associations of each segment under the expected conditions.

Materials and Methods

The Materials and Methods section is provided in **Supplementary Materials 1**.

Results and Discussion

Consumer liking and effect of nutritional information on sensory perception and purchase intention

Table 1 provides an overview of the data on liking and purchase intentions for the different PBCAs and dairy cheese. A significant difference ($p < 0.005$) was found between the liking scores of cheese samples under blind and informed conditions. Despite the blind and informed conditions, dairy-based cheese outperformed PBCAs in terms of sensory liking and purchase intention, confirming the anticipated preference for traditional cheese. Under blind conditions, no significant correlation was observed between the plant-based cheese liking scores. Interestingly, under informed conditions, PB1 showed a significant decrease in the liking score compared to the other two plant-based cheese alternatives. A similar observation was made between the purchase intention for PBCAs and dairy-based cheese. Purchase intentions differed significantly across all conditions for each cheese sample. In summary,

while ingredient information influenced expectations, sensory experience had a stronger impact on consumer acceptance of plant-based cheeses.

Table 1
Overall acceptability and purchase intention of samples in the blind and informed conditions.

	Overall acceptability		**Purchase intention**	
Products	*Blind*	*Informed*	*Blind*	*Informed*
PB1	4.26^{bB}	3.20^{cA}	2.99^{bB}	2.42^{cA}
PB2	4.26^{bA}	4.13^{bA}	3.05^{bB}	2.83^{bA}
PB3	4.56^{bA}	4.45^{bA}	3.25^{bB}	3.07^{bA}
DB	6.68^{aA}	6.91^{aA}	5.31^{aC}	5.71^{aB}

PB: Plant-based cheese; DB: Dairy-based cheese. Samples with the same letter within a column are not significantly different ($p < 0.05$). ^{ABC} Products with Different superscript letters indicate significant differences ($p \leq 0.05$) across the blind and informed conditions within a row.

Similar trends were reported by Jaeger et al. (2025) [7] in their study on New Zealand consumers evaluation of cheddar-based PBCAs. The consumer acceptability of the three PBCA products was significantly lower than that of dairy-based cheese, with all PBCA products rated between 3.1 and 3.6 (between “moderately disliked” and “slightly disliked”). These results are consistent with those of prior research by Falkeisen et al. (2022)[5], who studied the perception and emotional responses of Canadian consumers to locally available PBCAs. Based on the findings of previous studies, product packaging and ingredient information can increase or decrease expected liking scores[11, 18]. In contrast, studies by Schouteten et al. (2016) [15] on insect-based burgers and Grasso et al. (2022)[13] on hybrid burgers (in comparison with plant- and meat-based alternatives) reported a complete assimilation effect, where product information significantly influenced the overall preference.

Sensory drivers of liking and disliking

The results of the penalty analysis (Fig. 1), citation frequency (**Supplementary materials 2; Table S1**), and correspondence analysis (CA) (Fig. 2) of CATA demonstrated clear differences in the sensory drivers of liking and disliking of PBCAs. The penalty scores (Fig. 1) showed that "cereal flavour,” “artificial flavour, " and "strong aftertaste" had the greatest negative influence on liking, while "smooth mouthfeel,” “creamy” and "shiny" appearances yielded the highest lifting scores, indicating that texture and visual appeal were the crucial factors in liking.

As shown in Fig. 2, PB1 exhibited a mixture of positive (creamy and soft) and negative (bland and mild flavor, rubbery, and gritty) attributes, suggesting a lack of flavor acceptance despite the acceptable texture. Information on the ingredients of PB1 showed the addition of vegetable-based lactic cultures, coconut oil, and cashew nuts. Fermentation may be one of the reasons for the textural acceptance of PB1 over other plant-based cheeses. These findings are supported by Short et al. (2021b)[15], who reported a modified fermentation strategy to improve consumer preference by improving the beany and gritty mouthfeel of soy-based cheese. PB2 was associated with a strong aftertaste, oiliness, bitterness, and a vegetable-like flavor, suggesting challenges in flavor balance. PB3, which is associated with a nutty flavor and firmness, was also described as tasteless and cereal-flavored, highlighting the lack of flavor authenticity.

These results are in line with similar research where sensory attributes such as “smooth” “creamy” were identified as strong determinants of product acceptance of dairy-based mozzarella cheese [19], non-dairy mozzarella[6], and plant-based cheddar cheese[5]. Similar findings have been reported, where consumer acceptance of cheese is positively influenced by attributes such as softness, creaminess, and smooth texture[20–24]. Prior studies on soybean-derived PBCAs have reported undesirable beany and chalky flavors. [14]. Saraco and Blaxland (2020) [4] compared the organoleptic attributes and product performance of selected coconut-based mild cheddar and semi-hard Italian plant-based cheeses with their dairy counterparts. The authors concluded that neither the texture nor the flavor of the semi-hard Italian PBCAs was acceptable.

In summary, these findings suggest that although plant-based cheeses can replicate some of the textural properties of dairy cheese through fermentation, they face considerable challenges in achieving a balanced and appealing sensory profile. Texture and visual appeal are key determinants of liking, whereas off-flavors and undesirable mouthfeel would reduce acceptance.

Interpreting consumer segmentation: Conceptual associations and perception of healthiness

Cluster analysis revealed two distinct groups: “Adopters” (n = 176) and “Non-adopters” (n = 60), as detailed in **Supplementary Materials 2, Table S2**. Adopters, predominantly younger consumers (55% aged 18–34), showed significantly higher purchase intention (Table 2) for the cashew-based alternative (PB1) than the other clusters. This demographic shift toward plant-based proteins among younger populations suggests a growing openness to dietary transitions that prioritize sustainability and alternative protein sources. To further characterize these groups, we examined their health perceptions (Table 2). While the dairy control (DB) actually contained higher protein content (7.3 g vs. 3.0 g in PB1), the adopters perceived plant-based alternatives as healthier choices. Research shows that consumers often overestimate the healthiness of plant-based dairy alternatives compared to their actual nutritional content, reflecting perceptions influenced by the "plant-based" label rather than objective measures [25].

In contrast, the "Non-adopters" cluster provided lower and undifferentiated healthiness ratings across all samples, with no significant differences between plant-based and dairy mozzarella samples.

Table 2
Mean purchase intention and perceived healthiness of the samples under the expected conditions. Two-cluster solution (cluster 1 = 176; cluster 2 = 60) based on the aggregate sample (n = 236).

	Purchase Intention			**Perceived healthiness**		
Product	*Aggregate*	*Cluster 1*	*Cluster 2*	*Aggregate*	*Cluster 1*	*Cluster 2*
PB1	3.79^{a}	4.27^{b}	2.38^{b}	4.51^{a}	4.83^{a}	3.57^{a}
PB2	2.64^{d}	3.04^{d}	1.48^{c}	3.97^{b}	4.24^{b}	3.18^{a}
PB3	3.20^{c}	3.67^{c}	2.08^{b}	3.89^{b}	4.17^{b}	3.10^{a}
DB	5.65^{b}	6.12^{a}	4.25^{a}	3.89^{b}	4.08^{b}	3.27^{a}

Turkey’s honest significant difference (HSD) was used for the sample mean comparison. Samples with the same letter within a column are not significantly different ($p < 0.005$).

Correspondence analysis (Fig. 3) based on the CATA terms (**Supplementary materials 2; Table S3)** revealed that adopters tended to associate plant-based cheeses with concepts about PBCAS, such as “It is good for the environment,” “I could adopt this product for my regular consumption,” “Natural,” and “Healthy,” reinforcing their higher purchase intention and environmental awareness. For this group, the conceptual association and positioning of plant-based cheeses as nutritious, protein-rich, and environmentally responsible may reinforce positive perceptions and encourage repeat purchases. In contrast, the non-adopter segment, which included a greater proportion of older consumers, displayed a reluctance toward plant-based options despite recognizing some environmental benefits.

Jaeger et al. (2025) [7] noted that when a plant-based product is perceived as an "imitation," its health credentials are often dismissed by conservative consumers. For plant-based proteins to be integrated into long-term human nutrition strategies, they must overcome the perception that they are "ultra-processed" substitutes for animal-based protein. As suggested by Clegg et al. (2021) [3], the industry must not only improve the nutritional profile (e.g., matching protein quality) but also communicate these benefits in a way that overcomes the "artificial" stigma among consumers.

Adopters may be more inclined to consume plant-based cheese if they are aware of its nutritional, sustainable and environmental benefits. For non-adopters, sensory quality, authenticity, and affordability must be addressed. Bridging these gaps could not only expand the consumer base for plant-based cheeses but also contribute to a broader dietary transition toward sustainable food systems. The introduction of hybrid cheese products could accelerate non-adopters’ transition to a more plant-

centered diet, as proposed by Jaeger et al. (2025)[7], at least among those who are not ethically or religiously opposed to plant-based alternatives.

Limitations and future work

This study was conducted in a specific market (Montevideo, Uruguay), and cultural differences may have affected the generalizability of the results. Although research has focused on raw cheese, acceptance may differ if the cheese is melted or served with bread, as studied by Falkeisen et al. (2022b)[5]. It should be acknowledged that the expected condition was conducted with a separate group of consumers, which limits the direct comparability of the results to those that may arise from blind or informed evaluation. Future studies employing the same participants across all conditions would provide greater clarity by allowing intra-individual comparisons of purchase intentions, sensory drivers and conceptual associations. Future research should examine how targeted communication can effectively shift attitudes across different demographic groups and optimize sensory profiles.

Conclusions

This study emphasizes the perceptions of consumers regarding plant-based cheese in a market where dairy products are predominant. Based on our findings, dairy-based cheese consistently received the highest acceptance, whereas plant-based cheese alternatives struggled to meet the expectations of the Uruguayan consumers. Our first objective, to assess how nutritional and ingredient information influences sensory perceptions, showed that sensory experience remains the most influential factor influencing liking and purchase intention, whereas product information has no effect. Based on the second objective, PBCA exhibited a mixture of positive (creamy, shiny, and smooth mouthfeel) and negative attributes (artificial flavor and strong aftertaste), suggesting a lack of flavor acceptance despite an acceptable texture and the role of fermentation in modifying the texture. Finally, in addressing our third objective, consumer segmentation based on purchase intentions revealed two distinct groups: 'adopters' and 'non-adopters.' Adopters uniquely associate PBCAs with positive nutritional, health, and environmental attributes, reinforcing their higher purchase intention. In contrast, non-adopters were characterized by unique negative conceptual associations, perceiving PBCAs as processed, artificial, and unattractive, which served as the primary barrier to consumption. Plant-based cheese alternatives should be marketed based on their environmental and nutritional benefits while also addressing sensory and familiarity concerns to broaden their appeal. These outcomes collectively validate the expected challenges in flavor and sensory acceptance while confirming the predicted potential of sustainability-oriented consumer segments for market growth.

Declarations

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Author contributions

Cinu Varghese: Conceptualization, Methodology, Investigation, Formal analysis, Visualization, Writing – original draft, writing – review and editing, and software. Celina Sosa: Data Curation, Investigation. Julieta Maique: Data Curation, Investigation. Ana Curutchet: Investigation, Writing – review and editing, writing – original draft, Methodology, Conceptualization, Visualization, and Supervision. Patricia Arcia: Investigation, Writing – review and editing, Writing – original draft, Methodology, Conceptualization, Visualization, Supervision.

Consent To Participate and Human Ethics

This study was reviewed and approved by the Ethics Committee of the Universidad Catolica Del Uruguay (Solcomet 74). Respondents were provided with a consent form before the survey, and the questionnaire was administered only after their consent was obtained.

Consent for Publication

All authors have agreed to the publication of this manuscript.

Declaration of competing interest

The authors declare no conflicts of interest

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Figures

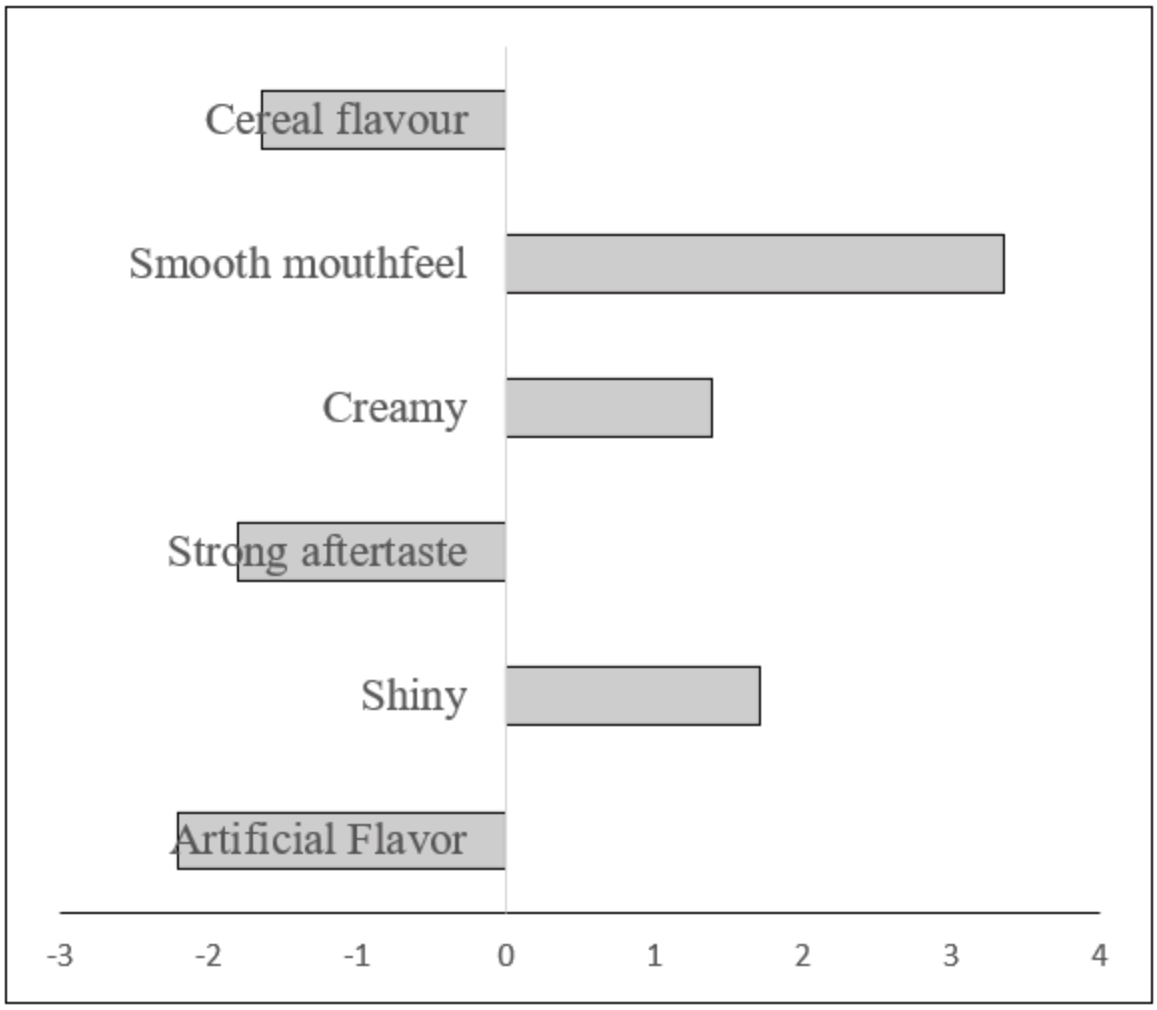


Figure 1

Penalty/Lift analysis of plant-based cheese alternatives along with dairy counterpart

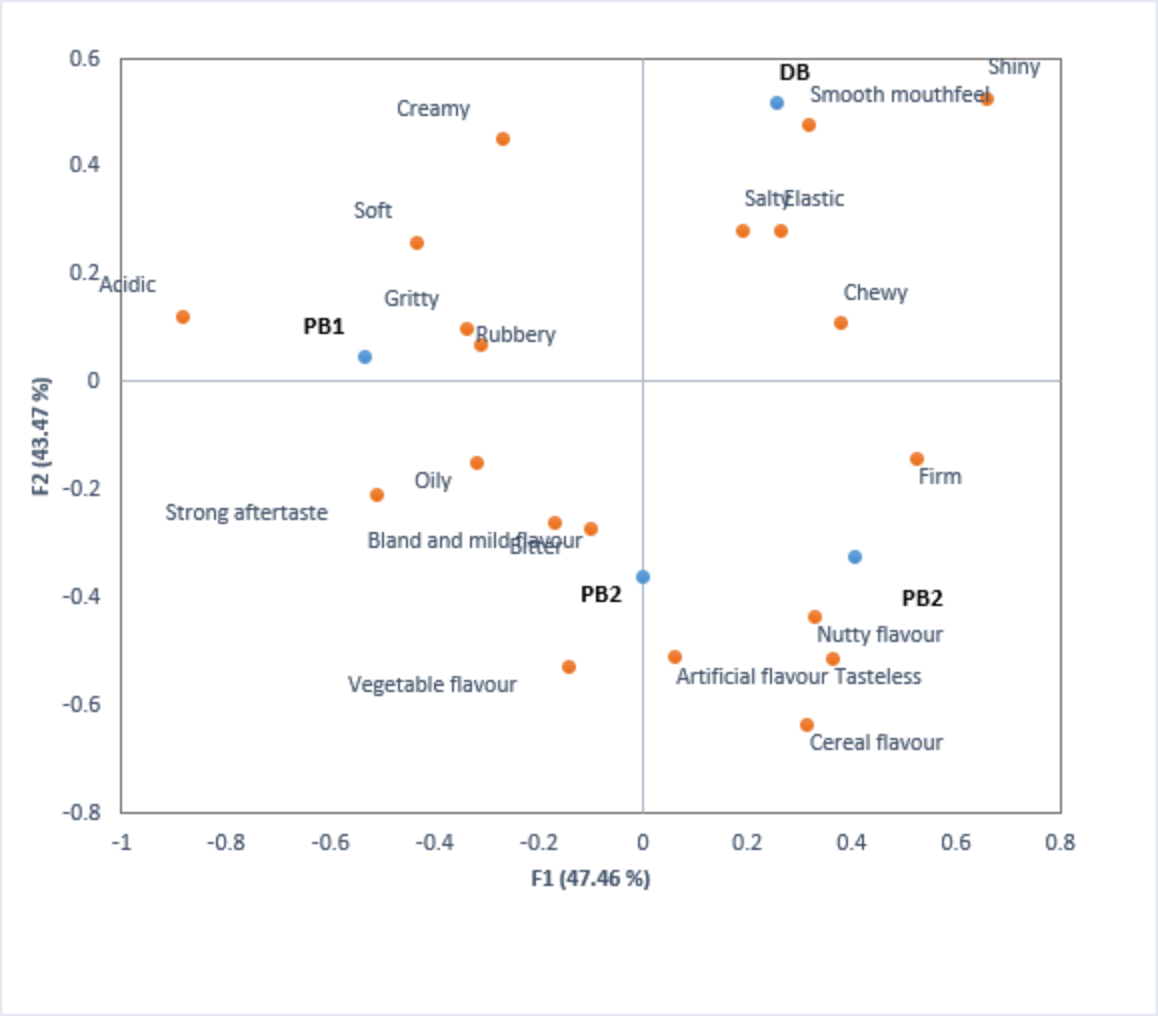
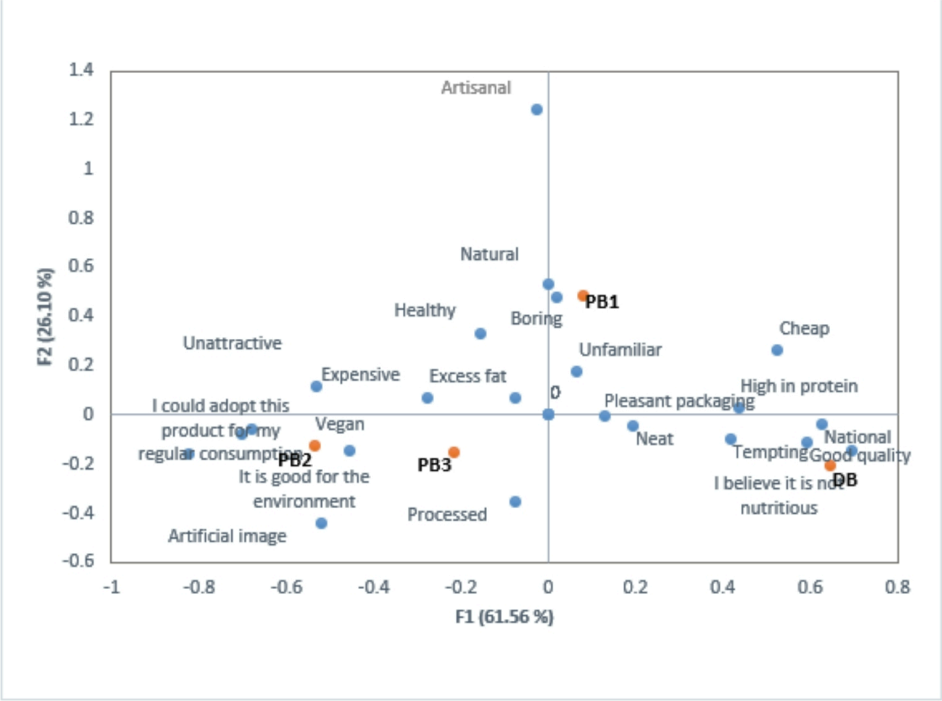
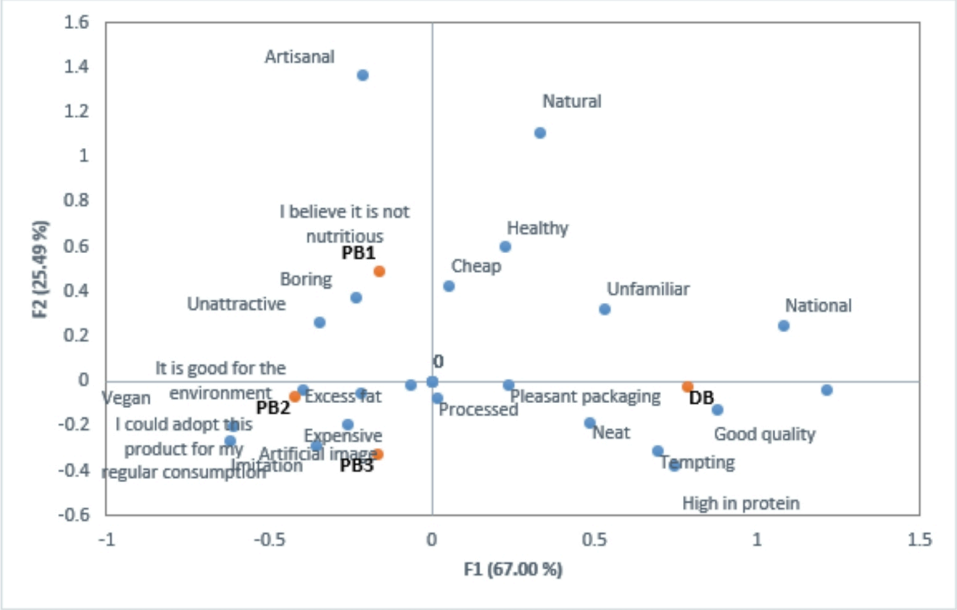


Figure 2

Biplot representation of plant-based cheese alternatives and dairy cheese samples on the first two dimensions of Correspondence Analysis. PB: Plant-based cheese; DB: Dairy-based



(a)



(b)

Figure 3

Biplot representation of plant-based cheese alternatives and the dairy cheese sample on the first two dimensions of Correspondence Analysis: a) Cluster 1 (adopters) b) Cluster 2 (non-adopters). PB, plant-based cheese; DB; Dairy-based cheese.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterials1.docx
- SupplementaryMaterials2.docx