International Journal of Food Science +Technology

Institute of Food Science +Technology ifst

Original article

The future of hybrid foods: will consumers embrace dairy-plant blends?

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(Received 30 July 2024; Accepted in revised form 12 August 2024)

Summary This study investigated the perception of Uruguayan consumers towards hybrid dairy-like products, including beverages and yogurts made with a mix of milk and plant proteins from canola, hemp, or soy. The study was conducted online with 261 participants, using a 2 × 4 experimental design to analyse consumer responses to product type and protein source. Results showed that dairy yogurt was the most preferred. Among plant protein ingredients, canola and hemp were the most and least preferred, respectively. Consumers rated each product on purchase intention, environmental friendliness, and other attributes through a comprehensive questionnaire. Findings indicated significant variation in purchase intentions based on product and protein type. Canola-based products were seen as more environmentally friendly compared to soy. Attributes such as 'Healthy', 'Contains calcium', and 'Contains proteins' positively affected purchase intentions, while negative perceptions about flavour impacted intentions adversely. Cluster analysis revealed significant differences across clusters regarding protein preferences and product types.

Keywords Canola, check all that apply, consumer survey, dairy, hemp, soy.

Introduction

There is a growing trend in the overall demand for protein, driven by global population growth, socioeconomic changes, such as rising incomes and increased urbanisation, and the recognition of the role of protein in a healthy diet (Henchion *et al.*, 2017). On the other hand, the increasing concerns regarding the sustainability of animal-based foods are driving a food transition in Western countries, which seeks to reduce the consumption of animal proteins by increasing the consumption of plant-based proteins (Guyomarc'h *et al.*, 2021).

However, promoting the consumption of plant-based proteins presents nutritional, techno-functional, and sensory challenges. First, there are questions related to nutritional aspects of vegetable proteins, such as amino acid profile, digestibility, and presence of antinutrients (Hertzler *et al.*, 2020; Day *et al.*, 2022; Floret *et al.*, 2023). Also, the low solubility of most plant proteins affects the stabilisation of colloidal food systems, constituting an important barrier to the replacement of animal proteins (Hinderink *et al.*, 2021; Tang *et al.*, 2023). In addition, the presence of off-flavours and off-odours, as well as unfamiliar flavour or texture, can impair the sensory quality of the potential food product (Aschemann-Witzel *et al.*, 2020; Jakobson *et al.*, 2023).

In that context, the development of so-called 'hybrid foods', in which animal proteins are partially replaced by plant proteins, has emerged as a strategy to reduce the carbon footprint of food, while maintaining the nutritional and sensory quality of the product (Guyomarc'h *et al.*, 2021). Due to their novelty, it is important to identify the consumers' perception towards the hybrid concept, type of product and its particularities, such as types of protein combinations and animal/plant-based protein ratios, in the early stages of the product development.

In the last few years, studies conducted to identify the opinions and attitudes of consumers about hybrid food products reported that an important proportion of the studied populations were open to the idea of consuming hybrid products, and that omnivorous were more likely to buy mixed foods than 100% plant-based substitutes (Tarrega *et al.*, 2020; Profeta *et al.*, 2021; Saint-Eve *et al.*, 2021; Drigon *et al.*, 2023; Östlund *et al.*, 2024). On the other hand, consumers driven by

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doi:10.1111/ijfs.17473

altruistic food-choice criteria, such as environmental sustainability or animal welfare, were less positive towards the idea of buying mixed food products (Drigon *et al.*, 2023). In addition, it has been identified that particularly for the group of consumers willing to buy hybrid foods, sensory appeal plays a more important role than environmental and health benefits (Grasso & Jaworska, 2020; Saint-Eve *et al.*, 2021; Banovic *et al.*, 2022; Drigon *et al.*, 2023; Östlund *et al.*, 2024).

Hybrid foods are not a food category, but a mixed food product, that could be in the form of drink, fermented beverage or gel, emulsion, burger, or sausage-like products. Several animal- and plant-based ingredients can be combined during the product development, and, therefore, the source of plant-based ingredient could also impact the perception of the consumers. Drigon *et al.* (2023) evaluated the consumers perception of milk-plant mixed products and found that French consumers preferred unfamiliar ingredients, such as lupine, over soy. Banovic *et al.* (2022) studied the European consumer attitudes towards hybrid burgers (50% meat-50% plant-based) and reported that, for Spanish consumers, rapeseed protein was the least appropriate ingredient, due to their lower familiarity, while Danish consumers had lower preference for soy. Moreover, for Spanish participants, pea protein had the highest appropriateness level, whereas UK participants preferred bean protein. These results highlight the importance of the cross-cultural differences among consumers, which are known to significantly impact the perceptions and attitudes of consumers (Ares *et al.*, 2015; Jeong & Lee, 2021; Perez-Pirotto *et al.*, 2023).

While several recent studies have looked at the perception and preferences of European consumers towards hybrid products (Grasso & Jaworska, 2020; Tarrega *et al.*, 2020; Profeta *et al.*, 2021; Saint-Eve *et al.*, 2021; Banovic *et al.*, 2022; Drigon *et al.*, 2023; Östlund *et al.*, 2024), only very little information has been published from other Western regions, such as Latin America. Further, most of the investigations were carried out on meat-hybrid products, and less information is available on the consumer attitudes or expectations of dairy-hybrid products.

Therefore, the objective of this study was to investigate the Uruguayan consumers' perception of two hybrid dairy-like products, beverage and yogurt, made from a mix of milk and a plant-based ingredient: canola, hemp, or soy. The main research questions were:

1 Has the type of hybrid product, yogurt or beverage, an effect on the purchase intention?
2 Has the plant-based ingredient (canola, hemp or soy) an effect on the purchase intention and perceived environmental friendliness of consumers?
3 Are there specific market opportunities for the evaluated hybrid products?
4 Do the socioeconomic factors of consumers impact the purchase intention of hybrid products?

Materials and methods

Participants

This study was conducted with a convenient sample of 261 voluntary respondents using an online panel hosted on Qualtrics survey platform (Qualtrics, Provo, UT) from November 2023 until March 2024. All participants lived in Uruguay and no compensation was provided for their participation. Participants were recruited via internet; no specific target group was defined for this exploratory study. Recruitment efforts were dispersed across various online platforms, including social media channels and institutional mailing lists, with no specific demographic targeting.

The participants received all the information about the study at the beginning of the survey and gave their informed consent. Participation was strictly anonymous, and the work has approval of the ethical committee of the Catholic University of Uruguay N° SOLCOMET 75.

The socio-demographic characteristics of the participants are shown in Table 1.

Stimuli and experimental design

To study the effects of type of product (2 levels) and protein source (4 levels) on the response of consumers, eight product packages were designed using a 2 × 4 experimental designs. Figure 1 shows the designed packages presented to the participants during the test.

Two traditional dairy products, namely yogurt and beverage, served as the product types, while four distinct protein sources (hemp, canola, soy, and dairy) constituted the protein variants. Each participant received all eight product packages images and was instructed to complete a questionnaire evaluating the product labels. The images were presented sequentially in a monadic design, with the order randomised across participants. For each label, participants rated their purchase intention on a 7-point scale ranging from 1 ('I would definitely not buy') to 7 ('I would buy'), assessed perceptions of environmental friendliness using 7-point scales (1: not at all friendly, 7: completely friendly), and completed a Check All That Apply (CATA) test encompassing twenty-eight attributes (Table 2), adapted from Drigon *et al.* (2023). Finally, the participants completed a socio-demographic questionnaire (Table 1), indicating their frequency of consumption of dairy products, and

Table 1 Socio-demographic characteristics of the participants [$N = 261$]

Variable	Category	%
Gender	Male	57
	Female	43
Age	17–29	26
	30–44	33
	45–60	28
	61 or older	13
Education level	Primary completed	1
	High school uncompleted	7
	High school completed	14
	Undergraduate	57
	Postgraduate	21
Number of children	None	66
	1	18
	2 or more	17
Monthly household income	Low [less than USD 1.200]	12
	Low-average [USD 1.200–USD 2.400]	28
	Low-high [USD 2.400–USD 4.000]	31
	High [more than USD 4.000]	29
Dairy frequency consumption	Daily	56
	More than once a week	29
	Al least once a month	10
	Less than once a month	2
Eating habits	Vegetarian	3
	Vegan	0
	Celiac	0
	Lactose intolerance	4
	Diabetic	1
	No dairy consumption	2
	Another eating restriction	2
	No eating restriction	88

questions about participant eating restrictions. Only complete forms were considered for analysis.

Statistical analysis

The utility value for each factor level, for the total consumer panel, was obtained from the Partial Least Square Regression (PLSR), being purchase intention and environmental friendliness the regression variables. An analysis of variance (ANOVA) of two factors, type of product and protein source, was applied to know which factor was significant. When the effects were significant, differences were calculated using Tukey's test ($\alpha = 0.05$).

The frequency of mention of each CATA term was determined. The Cochran's Q test was performed on the binary CATA data to determine significant differences between samples for each attribute ($P \leq 0.05$). To determine the impact of each attribute on liking, penalty-lift-analysis was used. For that, liking is averaged across all observations (consumers) in which the attribute was used to describe the product, and across those observations for which it was not used. The difference between these two mean values provides an estimate of the average change in acceptability due to the presence of the attribute. A Cochran Q test was performed on data obtained by the two CATA tests.

To identify consumer groups with different patterns for purchase intention, hierarchical cluster analysis was performed, considering Euclidean distances and Ward's aggregation method. For each consumer group, ANOVA of two factors, was performed. Composition of each cluster according to demographics data

Figure 1 Images of the packages of yogurt (a) or beverage (b) products, containing milk (1) or a mix of milk and soy (2), hemp (3) or canola (4) proteins, presented during the test.

Table 2 Attributes used in the CATA tests and their abbreviations used in Fig. 3

CATA attributes
It is healthy (healthy)
It is unhealthy (unhealthy)
It contains calcium (calcium)
It contains protein (protein)
I am concerned about being allergic (concerns about allergies)
It is good for the environment (good for environment)
It is bad for the environment (bad for environment)
It is a pleasant product (pleasant product)
I would not like flavour (would not like flavour)
It is fresh (fresh)
I would like the texture (would like texture)
I would not like the texture (would not like texture)
I would like the colour (would like colour)
I do not like these types of products (do not like product type)
I would prefer a product exclusively plant-based (prefer plant-based)
I could adopt this product for my everyday consumption (could adopt)
It's a product for dietary transition reducing animal ingredients (for transition)
It shakes-up tradition (shakes-up tradition)
It is for vegetarian people (for vegetarians)
It would be expensive (expensive)
It is nonsense (nonsense)
I do not know these ingredients (unknown ingredients)
I would like to taste it (would taste it)
I do not trust these ingredients (untrusted ingredients)
I would never taste it (would never taste)
I think is not nutritious (not nutritious)
It is original (original)
It is natural (natural)

were compared using the Chi-square test. Significant differences among proportions were determined using Marascuilo procedure (Levy, 1975).

Data analyses were performed using the software XLSTAT 2023.3.1 Version (Lumivero, NY, USA).

Results and discussion

Effect of type of product and protein source on purchase intention and environmental friendliness perception

The results of the ANOVA indicated that purchase intention of consumers varied significantly with the type of product and type of protein (Table 3). However, the consumer perceived environmental friendliness only varied significantly with the type of protein.

According to the utility values calculated for purchase intention, dairy yogurt was the product most preferred by consumers (Table 4). Among the plant proteins, canola had a higher purchase intention than hemp.

Table 3 Effect of type of product and protein source on purchase intention and environmental friendliness perception. Results of analysis of variance

	Purchase intention		Environmental friendliness	
Factor	***F***	***P***	***F***	***P***
Product	34.076	<0.0001	0.817	0.366
Protein	78.151	<0.0001	3.872	0.009
Product × Protein	12.784	<0.0001	1.429	0.232

Table 4 Utility values obtained for the purchase intention and environmental friendliness in relation to the type of product and protein source

		Utility values	
Factor	**Level**	**Purchase intention**	**Environmental friendliness**
Product	Yogurt	0.329^{a}	0.031
	Beverage	-0.329^{b}	−0.031
Protein	Dairy	0.930^{a}	0.087^{a}
	Canola	-0.130^{b}	-0.012^{a}
	Soy	-0.335^{bc}	-0.031^{b}
	Hemp	-0.479^{c}	-0.045^{ab}

Different letters between rows indicate significant differences ($P < 0.05$) in the utility values between levels of each factor.

The type of product (yogurt or beverage) had no significant ($P > 0.05$) impact on the perceived environmental friendliness (Table 3). On the other hand, products including soy protein were perceived as less environmentally friendly than products made from 100% milk or a mix of milk and canola (Table 4). In the study conducted by Drigon *et al.* (2023), the authors found that, while dairy-like products containing a mixture of lupine or pea and milk were perceived by French consumers as more environmentally friendly than 100% milk products, soy-milk mixed products were considerable comparable to milk. These results are aligned with the results obtained in the current study, in that soy is considered least environmentally friendly than other vegetable proteins. However, an important difference found between the results of both studies is that Uruguayans consumers, unlike French consumers, do not consider that regular dairy products exert a negative impact on environment. Interestingly, although consumers perceive soy products as unsustainable, different life cycle assessments have shown that when comparing the most common plant-based beverages, soy drink is the most environmentally friendly, especially when the nutritional value is considered (Geburt *et al.*, 2022; Singh-Povel *et al.*, 2022; de Jong *et al.*, 2024).

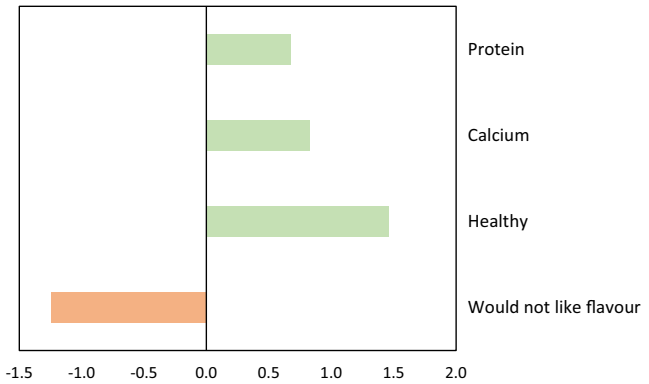

Figure 2 Results of the penalty-lift analysis. Only parameters with significant effect in purchase intention were included.

To understand the possible causes behind the obtained results, a penalty lift analysis was conducted over the 28 CATA terms (Table 2), to discern the attributes that account for differences in consumer liking scores. Among the attributes examined, only four exhibited a significant effect on purchase intention. Figure 2 shows that attributes such as 'Healthy', 'Contains calcium', and 'Contains proteins' were found to have a positive impact, while 'Would not like flavour' showed a negative effect. This suggests that nutritional attributes, such as the presence of protein and calcium in the product positively influences consumers' purchase intentions. Additionally, it underscores the importance of sensory attributes alongside nutritional aspects in eliciting favourable consumer responses. Martínez-Padilla *et al.* (2023) studied perceptions towards plant-based milk alternatives among consumers and non-consumers in Denmark, resulting taste, followed by health and naturalness, the main predictors for consumption of this kind of product. Malek & Umberger (2023) investigated consumers' motivations, intentions, and preferences regarding alternative protein sources using online survey data from a nationally representative sample of 1012 Australian, and their findings suggest there is interest in more traditional plant-based sources of protein, but that taste is a priority, along with price, health, and nutrition. Jaeger *et al.* (2024) studied the sensory drivers of liking/disliking in plant-based milk alternatives and reported that milk made from soy was most liked, resembled cow's milk most (taste and nutritionally). They also reported that hemp milk has a weak flavour, cardboard like, thin/runny and white colour and less accepted than soy milk.

Consumer segments

To identify possible patterns in the interest of consumers for the different products, cluster analysis was applied for purchase intention, identifying four clusters (CL1, CL2, CL3, and CL4).

ANOVA showed that the effect of type of protein was significant ($P < 0.05$) for the four clusters, while the type of product was significant for three of them (CL2, CL3, and CL4, Table 5). The size and sense of these effects varied among clusters, as shown by the utility values in Table 6.

Table 7 shows the demographic characteristics of each cluster. Consumers in cluster 1 (CL1), comprised mainly of middle-aged individuals with medium to high frequency of dairy consumption showed no preference for yogurt or beverages. In contrast, the other three clusters exhibited a significant preference for yogurt over beverage (Tables 5 and 7). With respect to protein preferences, CL1 should be interested in hemp as source of protein, followed by canola, showing less interest in soy as well as dairy (Table 6). This group's decreased interest in dairy protein may be due to its bigger proportion of vegetarian individuals.

Cluster 2 (CL2) comprised of middle-aged people, with a high education level, should be interested in canola, hemp, and dairy, but not in soy. Regarding hemp interest, results are in accordance with Kim & Mark (2023) who reported that higher education and income USA households were more likely to buy hemp products and were associated with significantly higher consumption levels.

Clusters 3 and 4 (CL3 and CL4) showed higher purchase intention for 100% dairy products than for hybrid products. While CL3 people did not prefer any hybrid mix above other, CL4 showed the least preference for products containing hemp and was the only cluster where soy-containing products did not show the least purchase intention. Interestingly, CL3 was

Table 5 Influence of information about type of product and protein on consumer interest on dairy products for each cluster identified. Results of Analysis of Variance. *F* (4, 1, 4) ratio and probability (*P*) values

	CL1 (5%)		CL2 (31%)		CL3 (27%)		CL4 (37%)	
Source	***F***	***P***	***F***	***P***	***F***	***P***	***F***	***P***
Product	1.867	0.175	12.977	0.000	17.189	<0.0001	25.454	<0.0001
Protein	5.940	0.001	18.290	<0.0001	75.099	<0.0001	127.991	<0.0001
Product*Protein	0.069	0.976	0.270	0.847	20.359	<0.0001	15.243	<0.0001

Table 6 Values of the parameters of the utility model for each cluster in relation to the type of product and type of protein

Variable	CL1	CL2	CL3	CL4
Constant	5.712	3.420	1.815	4.073
Beverage	−0.202[a]	−0.270[b]	−0.318[b]	−0.397[b]
Yogurt	0.202[a]	0.270[a]	0.318[a]	0.397[a]
Canola	0.031[ab]	0.041[a]	−0.339[b]	−0.160[b]
Hemp	0.836[a]	0.144[a]	−0.614[b]	−1.187[c]
Dairy	−0.366[b]	0.402[a]	1.287[a]	1.356[a]
Soy	−0.501[b]	−0.594[b]	−0.341[b]	−0.044[b]

Different letters between columns indicate significant differences ($P < 0.05$) in the utility values between clusters.

the cluster with the larger number of people above 45 years old, while CL4 had the highest proportion of young people, consistent with its lower proportion of people with high education levels (Table 6). CL4 also had the highest proportion of people with daily frequency consumption. The fact that young people were less interested in vegetables proteins contrasts with results obtained by Alae-Carew *et al.* (2022) who reported that millennials (age 24–39 years) were the most likely generation to report plant-based alternative foods consumption compared to traditionalists (age 75+ years).

Previous studies have reported that females were more prone to consumption of plant-based alterative foods (Alae-Carew *et al.*, 2022; Martínez-Padilla *et al.*, 2023). However, no significant differences were found among gender integration of the different clusters, in the current study.

Principal component analysis

To understand the differences among products perceived by consumers, a principal component analysis (PCA) was performed for each cluster (Fig. 3). As general comment, all clusters associated 100% dairy products with 'protein', 'calcium', and CL2, CL3, and CL4 also perceived them as 'healthy' and as a 'pleasant product'. In the case of CL1, dairy protein is not perceived as 'healthy', and this may be related with the eating habits of this group, as this is the cluster with the highest percentage of vegetarians.

People in CL1 showed positive attitudes towards hybrid products containing hemp and canola, which were the preferred protein sources according to purchase intention interest (Table 6) and associated them with the CATA terms 'natural' and 'shakes-up tradition'. People in CL1 and CL2 considered hybrid yogurts with hemp and canola as 'good for environment'. On the other hand, soy was rejected in these clusters, especially in CL2, where soy was associated with the terms 'untrusted ingredients', 'unhealthy', 'bad for environment', 'allergies', and 'do not like product type'. According to Schyver & Smith (2005), the greatest barrier to soy consumption was its largely unfavourable image.

People in CL3 and CL4, were only interested in traditional 100% dairy products, and associated them

Table 7 Distribution of consumers (%) on clusters, according to demographics characteristics. Difference among proportions test, χ^2 and probability (P) values

Characteristic	Level	CL1	CL2	CL3	CL4	χ^2	P
Gender	Women	62	60	59	52	1.586	0.677
	Men	38	40	41	48		
Age	17–29	23[ab]	20[ab]	17[a]	38[b]	11.755	0.008
	30–44	31	35	34	31	0.301	0.960
	45–60	31	30	33	22	2.807	0.422
	61 years or older	15	15	16	9	4.436	0.218
Education level	Incomplete high school	8	5	7	7	0.531	0.912
	Completed high school	38	33	36	50	5.648	0.130
	Bachelor and/or postgraduate	54[ab]	62[a]	56[ab]	41[b]	8.405	0.038
Dairy consumption frequency	Daily	62[ab]	52[ab]	41[a]	69[b]	12.945	0.005
	More than once a week	38	27	30	28	0.763	0.858
	Al least once a month	0[a]	13[b]	17[b]	2[a]	13.622	0.003
	Less than once a month or never	0[a]	7[ab]	11[b]	1[ab]	8.900	0.031
Eating habits	Vegetarian	8[a]	1[b]	7[a]	1[b]	7.513	0.047
	Lactose intolerance	8	6	4	2	2.357	0.502
	Diabetic	0	1	1	0	1.414	0.702
	No dairy consumption	0	2	4	0	4.517	0.211
	Another eating restriction	0	2	3	1	1.067	0.785
	No eating restriction	84[ab]	88[ab]	80[a]	96[b]	10.630	0.014

Different letters between columns indicate significant differences ($P < 0.05$) in the consumers distribution between clusters.

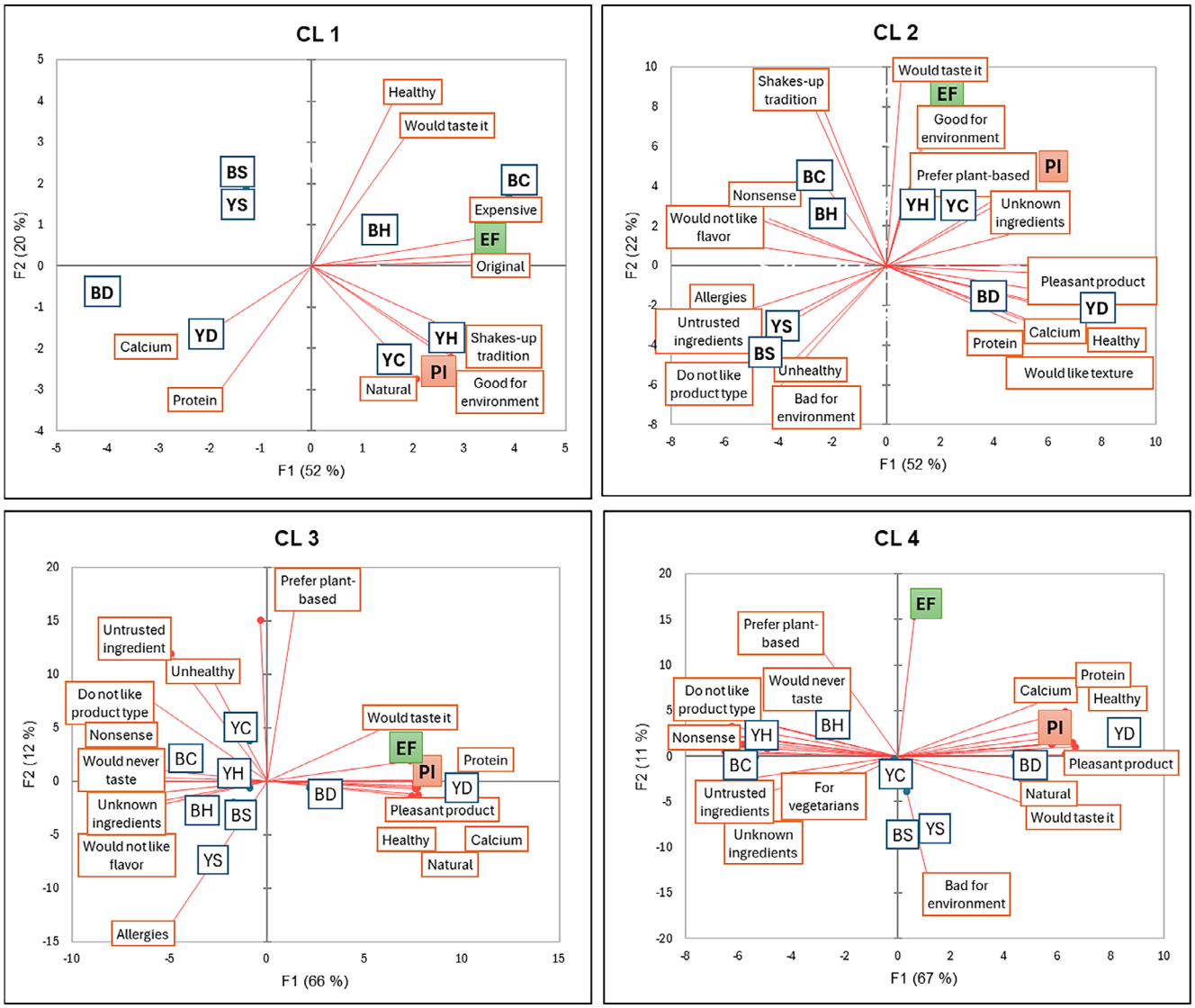

Figure 3 Principal component analysis for each cluster (CL1, CL2, CL3, and CL4). BC, canola-dairy hybrid beverage; BD, dairy beverage; BH, hemp-dairy hybrid beverage; BS, soy-dairy hybrid beverage; EF, environmental friendliness; PI, purchase intention; YC, canola-dairy hybrid yogurt; YD, dairy yogurt; YH, hemp-dairy hybrid yogurt; YS, soy-dairy hybrid yogurt.

with 'healthy', 'pleasant product', 'protein', 'natural', and 'calcium'. Those consumer segments showed a negative attitude towards hybrid products containing hemp and canola, associating them with the terms 'untrusted ingredients', 'nonsense', 'do not like product type', 'unknown ingredients'. In the case of CL3, hemp and canola were considered almost as negatively as soy, and associated it with the term 'allergies', while people in CL4 associated soy-milk hybrid products with 'bad for environment', in agreement with Drigon *et al.* (2023) findings.

Unfamiliarity with the ingredients seemed to have influenced the negative attitudes of consumers in CL3 and CL4 towards hybrid products, especially those containing hemp and canola. On the other hand, it did not affect negatively the purchase intention of hemp-milk and canola-milk hybrid yogurts of consumers in CL1 and CL2. Further, the 'unknown ingredients' and 'shakes-up tradition' terms correlated positively with the purchase intention for CL2 and CL1, respectively, indicating that the novelty factor could be appealing for these segments.

While meeting nutritional, ethical, and/or sustainability demands could be a driver of the acceptance of innovative products, such as hybrid foods, they could also remain as niche products if consumers reject them, based on the perception of lack of naturalness or poor sensory properties (Tuorila & Hartmann, 2020). Indeed, the results of the current study show that the largest consumer segment (CL3 + CL2) clearly preferred traditional dairy products over hybrid ones (Tables 5 and 6). Therefore, considering that such hybrid products are not in the Uruguayan market yet, the consumers are not familiarised with them.

Introducing unfamiliar ingredients in food products can either appeal or retract consumers. For some, novelty sparks curiosity and a desire to explore new culinary trends. Others, however, view unfamiliarity as a barrier, prioritising safety and tradition in their food choices. Indeed, Tuorila & Hartmann (2020) found that while innovative products like meat alternatives and wellbeing products may meet certain demands, perceptions of unnaturalness or poor sensory properties can limit their acceptance, potentially relegating them to niche status.

Environmental friendliness perception seemed to be only correlated with a high purchase intention in CL3. However, it can be noted that in the clusters where hybrid products were preferred over (CL1) or as much (CL2) as 100% dairy products, canola-milk and hemp-milk mixed yogurts were associated with the term 'Good for environment'. In the case of CL4, the cluster with the highest proportion of young consumers, the perception of sustainability did not exert an important impact on purchase intention. This result agrees with Martínez-Padilla *et al.* (2023) findings, who reported that young people, both consumers and non-consumers of plant-based milk alternatives showed a neutral attitude towards the environmental friendliness of such products.

Limitations of the study

The online study was carried out with 261 respondents in a convenience sample that, while adequate for initial insights, may not fully represent the Uruguayan population or capture the full spectrum of consumer preferences and behaviours. Additionally, the delivery form of the study may introduce a selection bias, favouring respondents who are more technological or have specific interests in these dietary products. Therefore, study's results should be interpreted with care and can only be generalised to population groups with similar sociodemographic characteristics.

Future studies should explore the sensory profiles and nutritional benefits of these hybrid products in depth to better understand consumer acceptance. Moreover, expanding this research to include different demographic groups could provide a broader understanding of consumer attitudes across various populations, potentially guiding more targeted marketing strategies.

Conclusions

This study explored the perceptions of Uruguayan consumers towards hybrid dairy-like products combining milk and plant-based proteins. It revealed a marked preference for yogurt over beverage in terms of purchase intention. Interestingly, consumers showed no clear preference for either product based on their perceptions of environmental friendliness.

With respect to plant proteins source, canola was the most preferred while hemp was the least preferred. Products containing soy were perceived as less environmentally friendly than products made from 100% milk or a mix of milk and canola.

The cluster analysis identifies promising market opportunities for introducing canola and hemp-based hybrid products, particularly in beverage form. These hybrids are well-positioned to appeal to niche markets that are actively seeking alternative dairy options. Two of the total four identified clusters (CL1 and CL2) showed higher or equal purchase intention for canola-milk and hemp-milk hybrid yogurts than for the traditional 100% dairy products, associating such products with a positive effect on environment. On the other hand, clusters containing the largest proportion of people above 45 (CL3) and below 29 (CL4) years old showed the most conservative behaviour, with a clear preference of 100% dairy products over hybrids. The study demonstrated that people preferring traditional pure dairy products value them for their sensory and nutritional properties, while they have a distrustful attitude towards hybrid products.

The results of the study underscore the importance of educating consumers on the environmental impacts of food products, as well as the need for effective communication about the environmental and nutritional benefits of hybrid products to enhance consumer acceptance.

Acknowledgments

Authors want to acknowledge Jimena Llano for the image design and practical help.

Author contributions

Ana Curutchet: Conceptualization; investigation; writing – original draft; writing – review and editing; formal analysis. **Patricia Arcia:** Writing – original draft; writing – review and editing; formal analysis; investigation. **Mariana Rodríguez Arzuaga:** Conceptualization; investigation; writing – original draft; writing – review and editing.

Conflict of interest

The authors declare no conflicts of interest.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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