

Valuing consumer preferences and motivations for plant-based beverages: A CUB model analysis

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ABSTRACT

Food consumption trends have evolved significantly in recent years due to increased attention to environmental sustainability and the search for nutritionally balanced, health-beneficial food. In this context, plant-based beverages (PBBs) represent a rapidly growing segment. This study analyses the PBBs preferences and motivations of consumption, studying how socio-demographic characteristics influence purchase drivers and identifying the role of certification-related eating styles and habits in the importance attributed to PBBs characteristics. An online questionnaire was conducted in the South-East of Italy with a sample of 233 respondents. A methodology utilising a Combination of Uniform and Shifted Binomial random variables, the CUB model, was employed to assess consumers' perceptions across two key dimensions: feeling and uncertainty. Results suggest that the two most important PBBs attributes considered in the decision-making process were taste and expiration date; the main reasons for PBBs consumption were the presence of vitamins and minerals and beneficial health ingredients. Moreover, considering socio-demographic characteristics and the consumption habits as covariates, different profiles of consumers of this product emerged. This research fills gaps in the literature on consumer characterisation of PBBs and offers a broader perspective, including the examination of attributes where consumers are uncertain about the level of importance they attach.

1. Introduction

Food consumption trends have changed significantly over the last century, driven by economic and environmental crises, growing health concerns, and an ever-expanding product offering (Santeramo et al., 2018). In particular, consumers are increasingly influenced in their food choices by the nutritional characteristics and health benefits derived from their food consumption patterns and orientation (Asioli et al., 2017). The search for healthy nutritional components in diets is linked to a greater pursuit of well-being, as well as a growing concern about diet and lifestyle-related diseases such as diabetes and obesity, along with an increase in intolerances and allergies (Baker et al., 2020; Dicken and Batterham, 2022).

Over the past a few years, the attention of individuals to the nutritional aspects of food and the responsibility of consumers toward sustainability during decision making has increased (Buerke et al., 2017;

Maduku, 2024). The weight of this combination in healthy-sustainable consumption patterns is product-specific because some food products are characterised by ethical and social involvement that consumers consider in their food choice, as well as increased social responsibility (Peano et al., 2019). This is particularly true for animal-based products, such as milk and meat, whose consumption has declined in recent years, especially among Western consumers, due to negative perceptions regarding the ethical, environmental, and social impacts of these products (Boaitey and Minegishi, 2020). At the same time, the presence of plant-based products as alternatives to animal protein are increasing in the market and in the dietary patterns of modern consumers (Habib et al., 2024).

Plant-based diets have become crucial as alternative protein sources, contributing to reducing environmental impact, promoting animal welfare, and providing healthful nutrients for human well-being (Donato et al., 2024; Reyes-Jurado et al., 2021; Sottile et al., 2023).

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Despite challenges such as higher prices and nutritional limitations compared to dairy, plant-based beverages (PBBs) continue to rise in popularity. PBBs are liquids obtained by maceration and subsequent filtration of plant raw materials such as cereals, legumes, seeds or nuts, which gives them their nutritional and organoleptic properties. Initially seen as a dairy alternative for individuals with lactose intolerance or those following a vegan or vegetarian diet, these products have recently experienced a growing consumer base (Jaeger and Giacalone, 2021; McCarthy et al., 2017a). A recent review highlighted the key drivers of the growing trend of PBBs, including growing health concerns and increasing awareness of environmental sustainability and animal welfare (Sharma et al., 2024). Moreover, this trend has been supported by significant innovations in raw material selection and production processes, contributing to a wide variety of PBBs. Product differentiation strategies have expanded, especially in large retail chains, which now offer multiple formats targeting different consumer preferences and distribution channels (Mastromonaco et al., 2023).

Several studies already investigated the reasons behind the purchase of PBBs as alternatives to cow's milk (Acquah et al., 2023; Cardello et al., 2022; Haas et al., 2019; Mastromonaco et al., 2023; Sottile et al., 2023). For example, nutritional information on the label is a significant factor influencing the choice of these products, especially the presence of micronutrients with beneficial health effects, such as vitamins, minerals, and functionally active components (Oduro et al., 2021; Paul et al., 2020).

In addition to nutritional aspects, significant determinants for the PBBs consumption to cow's milk include the ethical and environmental sustainability of the product. A study conducted by Mastromonaco et al. (2023) highlighted that PBB consumers were particularly sensitive to environmental issues and animal welfare. It has been observed that plant-based substitutes, especially those made from almond and soy, have a lower environmental impact in their production (Grant and Hicks, 2018; Poore and Nemecek, 2018). Several studies have also shown that the consumers with high environmental awareness are more likely to perceive PBBs as environmentally friendly and are willing to try these products (Rombach et al., 2024) or pay a premium for them (Su et al., 2024). Additionally, previous research findings also revealed that animal welfare significantly influenced consumers' preferences for PBB alternatives. Specifically, individuals with ethical awareness tended to be more willing to try plant-based milk alternatives (Rombach et al., 2024) and expressed greater commitment to PBB products (Rombach et al., 2023).

On the other hands, the product formulation stage (by industries) and assortment decisions (by retail chains) must consider the motivation of consumer rejection of PBBs. The primary barrier to acceptance lies in the sensory aspect, particularly the lack of sensory satisfaction after consumption, especially when compared to the sensory characteristics of cow's milk (Giacalone et al., 2022; Sottile et al., 2023). However, different studies indicate that the choice of raw materials and the production process can enhance the taste, which is one of the most influential factors in food choices (Kempen et al., 2017). In this context, understanding which attributes of PBBs are perceived as most valuable during the purchasing process is of paramount importance for manufacturers and distributors to align their offerings with consumer demands and needs. This is particularly relevant in a market context where the array of brands and product ranges continues to expand (Mastromonaco et al., 2023; Sottile et al., 2023). It has been observed that large retail chains aim to offer a broad range of PBBs, with a prevalence of leading brands in terms of the number of products and raw material types. However, these products often lack nutritional and health-related label information (Angelino et al., 2020; Mastromonaco et al., 2023). Label information allows manufacturers to attract consumers based on one or more product characteristics and create a perception of higher quality (Pérez-Rodríguez et al., 2023). Therefore, it is crucial to comprehend the purchasing choices and consumption motivations of various consumer groups for PBBs to meet their diverse

needs (Kraus et al., 2017; Massaglia et al., 2023; Merlino et al., 2023).

Socio-demographic characteristics (SD), such as age, gender, and education level, have been found to correlate with consumer preferences (Dominici et al., 2021). The purchase and consumption of PBBs is significantly influenced by these factors (Baş et al., 2024; Cardello et al., 2022; Cichońska and Ziarno, 2021; Sottile et al., 2023). Specifically, Baş et al. (2024) investigated the purchase behaviour of PBBs based on gender, income level, lactose intolerance and environmental issues, and found that health concerns and low income positively influenced the purchase of these products. Furthermore, Cichońska & Ziarno (2021) explored the drivers of purchase and reasons for consumption among young, educated women and found that vitamin and mineral fortification, along with taste, were key purchase drivers in this consumer segment.

Additionally, a recent systematic review on consumer acceptance of alternative proteins highlighted the influences of dietary habits on acceptance of alternative protein products (Onwezen et al., 2021). Cardello et al. (2022) also found a strong association between eating habits and the preferences for the unsweetened cashew-based milk.

Despite these findings, research gaps exist. Firstly, few studies have explored the consumers' perception of various PBBs attributes in relation to age and gender differences (Appiani et al., 2023). Secondly, there is limited research investigating the influence of individual characteristics in terms of the psychological aspects, such as uncertainty in decision-making process, that affect consumer choices. Additionally, few studies in Italy have analysed consumer preferences based on consumption habits and attention to product origin certifications, especially in relation to a traditional plant-based beverage like almond-based products.

To address the gaps in the literature on characterising PBB consumers, this study aimed to enhance understanding of PBBs preferences and consumption motivations. It explored how socio-demographic characteristics influence purchasing drivers and examined the role of certification-related eating styles and habits in shaping the importance attributed to PBB characteristics. The study focused on consumers living in Puglia, the second-largest almond-producing region in Italy, located in the south-eastern part of the country, to achieve the following objectives:

1. To determine the level of importance attributed to different extrinsic, intrinsic, and credence characteristics of PBBs, as well as the level of uncertainty in attributing this importance to each attribute;
2. To understand the motivations driving the consumption of PBBs;
3. To examine how socio-demographic characteristics and consumption habits influence the importance attributed to PBBs consumption attributes and motivations;
4. To identify the role of certification-related eating styles and eating habits in the attribution of liking to different attributes of PBBs.

To reach the goals, the Combination of Uniform and Shifted Binomial (CUB) random models were adopted, these models set themselves apart from other techniques for analysing ordinal data and efficiently handles the assessment data provided by consumers. This methodological combination allowed us to assess the connection with SD, eating habits, preferences toward a heterogeneous set of attributes (credence, intrinsic and extrinsic) and motivations in a single choice experiment while simultaneously considering the psychological aspect of uncertainty, a very important variable reflecting the real product choice condition in the real world. In fact, this innovative approach was developed to provide a more flexible representation of ordinal data than traditional distributions, which sometimes do not capture the discrete nature of the data. It enables the analysis of complexities behind preference choices, which do not always follow a strictly deterministic logic (Piccolo, 2003). Furthermore, the uniqueness of the CUB model lies in its ability to analyse not only preferences for specific items, but also the uncertainty that consumers may experience when giving their final responses

(Iannario and Piccolo, 2011; Punzo et al., 2018). This makes it possible to assess the cognitive and psychological processes that guide final consumer choices in the agri-food supply chains.

To our knowledge, CUB model has not previously been applied in the literature to analyse consumer preferences for PBBs. Therefore, the application of this model in the present study provides a significant contribution to the existing research by introducing a novel methodological perspective. The ability of the CUB model to capture the duality between specific tendencies and components of uncertainty makes it particularly suitable for studying a product category such as PBBs, which is still relatively new and perceived as an alternative to traditional animal-based product. Moreover, the need to use the CUB model in this context stems from the unique characteristics of the PBBs market. Consumers' preferences in this area are often influenced by a combination of factors, such as unfamiliar taste profiles, health-related perceptions and price considerations (Giacalone et al., 2022; Jaeger and Giacalone, 2021; Sharma et al., 2024), which may lead to different degrees of uncertainty in their decision-making process. This statistical method enables understanding of which PBBs attributes consumers have more definite preferences for (low uncertainty and high liking) and which they are more indecisive about (high uncertainty). This makes it particularly useful in a complex and evolving market like PBBs, where consumer familiarity with the product category is still developing. Thus, this study not only enriches the literature about PBBs consumers preferences but also provides insights that can enhance marketing strategies and product development in the PBBs sector.

2. Materials and methods

2.1. Data collection

An online survey was sent to participants from the Puglia region (Southeast of Italy) using social media, between May and September 2022. The research adhered to the ethical standards outlined in the Declaration of Helsinki and was approved by the Bioethics Committee of the University of Turin (protocol number 0202,725, 13/04/2022). Participants were at least 18 years old and provided informed consent before beginning to complete anonymously the questionnaire in Italian. The questionnaire comprised four sections. The first section investigated the socio-demographic characteristics of the respondents. In the second section, the participants' dietary habits (attention to calories, fresh food preference, focus on quality, focus on taste and nutrient-balanced diet), eating styles and the importance attributed to three product certifications (i.e. organic certification, local origin, and "made in Italy") were collected (Annunziata and Mariani, 2018; Bojnec et al., 2019; Varaldo et al., 2022). The third section included questions regarding the importance measured with a 7-point Likert scale (from 1 = "not at all important" to 7 = "extremely important") placed on 16 nutritional characteristics and sustainability-related aspects of PBBs, derived from the combination of items already used by Giacalone et al. (2022) and Sottile et al. (2023). The scale readability was measured using the Cronbach's alpha test (0.95). The 7-point Likert scale was also employed in the subsequent section, where consumers were asked to indicate the importance of 7 motivations for consuming PBBs. In the Supplementary Materials, the Table A1 lists all the attributes investigated, categorized as credence attributes, intrinsic attributes and extrinsic attributes, together with the consumption motivations for PBBs considered in this study.

Finally, in the last part of the questionnaire, purchasing and consumption habits of PBBs were investigated, including types consumed, places of purchase, and consumption frequency.

2.2. Statistical analysis

The consumer preferences for PBBs attributes and consuming motivations, collected through the questionnaires, were processed using a

Combination of Uniform and Shifted Binomial (CUB) random models. These models are useful for analysing the level of liking for each selected attribute and the effect of uncertainty on their judgment. Furthermore, the use of covariates allowed us to understand whether socio-demographic characteristics and lifestyle aspects can influence the importance attributed by the sample to the product features under consideration (Gambacorta and Iannario, 2013; Piccolo, 2003; Piccolo and D'Elia, 2008). CUB models are a class of models for representing ordinal data through a mixed distribution, following a probabilistic approach. It is a methodology for analysing consumer preferences through two latent components that influence the choice among different ordered discrete alternatives. These two components are represented by liking, which is the importance attributed to an item, and uncertainty in providing the response (Corduas et al., 2013; Iannario and Piccolo, 2011). The use of this methodology is based on the belief that the psychological process behind purchase decisions is influenced by two different and related factors. Satisfaction and preference for an attribute are combined with indecision among different alternatives, the time spent in responding, lack of knowledge, and confusion (associated with uncertainty). In the application of this methodology, consumers must express their preferences using a Likert scale with >3 points ($m > 3$) (Iannario and Piccolo, 2010). In this study, we used an ordered Likert scale with 7 levels ($m = 7$), and the resulting evaluations, which reflect consumer preferences, are described by a discrete random variable (R) obtained from the equation:

$$P(R=r) = \pi \binom{m-1}{r-1} (1-\xi)^{r-1} \xi^{m-r} + (1-\pi) \frac{1}{m} \quad r = 1, 2, 3, \dots, m \quad (1)$$

where ξ and π are the two associated parameters, respectively, with liking and uncertainty, and they range between the values 0 and 1 (Iannario and Piccolo, 2010). When $\xi \rightarrow 1$, the distribution curve shifts towards a lower rating score; conversely, when $\xi \rightarrow 0$, the distribution mass tends towards higher ratings. Similarly, when $\pi \rightarrow 1$, the weight of uncertainty decreases, and the variable R tends to appear as a shifted binomial distribution (D'Elia and Piccolo, 2005; Iannario and Piccolo, 2011). Therefore, for a more understandable interpretation of the results, Iannario & Piccolo (2011) suggest that the measure of uncertainty in making a decision is expressed as $1 - \pi$, and the measure of preference as $1 - \xi$. To estimate the fitness of the data to the estimated CUB model, the dissimilarity index (*Diss*) is used, which should be <0.15 (Iannario, 2009). The respondents' socio-demographic characteristics and habits can have an impact on the parameters related to liking and uncertainty. For this purpose, CUB models can be estimated using covariates p and q , which respectively pertain to uncertainty and liking (Iannario and Piccolo, 2011). In this study, we employed covariates for linking to examine how consumer characteristics affect the importance attributed to the parameters of PBBs and motivations of their consumption. Therefore, a CUB model ($0, q$) was performed. The covariates employed for liking are described in Table 1 below.

This statistical methodology was applied using the RStudio software, and particularly the "CUB" package version 1.1.5.

3. Results

3.1. Socio-demographic characteristics of the sample

In total, 233 participants completed the online questionnaire, and their socio-demographic characteristics are detailed in Table A2 of the supplementary materials. The sample was evenly distributed between men and women, with a relatively high level of education on average (nearly 50 % of the sample had a bachelor's degree, and approximately 12 % held a postgraduate degree).

About 43 % of the respondents were between 18 and 35 years old, but a significant percentage of participants fell within the over 55 age group (30 %). The sample had a higher representation of individuals

Table 1
Covariates for liking (ξ).

Covariates	Items	Parameters
Socio-demographic characteristics	Gender	Women, Men
	Age (range)	18–25, 26–35, 36–45, 46–55, over 55
	Presence of children	Yes, No
Certification-related eating style	Sport practice	Yes, No
	Organic certification	High preference for foods with organic certification
	Local origin	High preference for foods locally produced
	Italian origin	High preference for foods produced in Italy
Eating habits	Attention to calories	7-point Likert scale
	Fresh food preference	7-point Likert scale
	Focus on quality	7-point Likert scale
	Focus on taste	7-point Likert scale
	Nutrient-balanced diet	7-point Likert scale

who engaged in sports activities (around 65 %) compared to those who reported otherwise. Conversely, the presence or absence of children was balanced within the sample analysed.

3.2. The CUB (0,0) model (without covariates)

Fig. 1 illustrates the rating distribution of each attribute [Fig. 1(A)] and consuming motivation [Fig. 1(B)] of the PBBs considered in this study. The parametric space (unit square) displays the coefficients estimated by the CUB (0,0) model for each characteristic: degree of importance ($1 - \xi$) on the ordinate and degree of uncertainty ($1 - \pi$) on the abscissa.

Visually, it can be observed in Fig. 1(A) that the taste attribute is positioned in the upper left corner, indicating that respondents consider it as the most important feature of PBBs [$(1 - \xi) > 0.9$] and assign it a score with low uncertainty [$(1 - \pi) < 0.5$].

The sample also assigned categorical importance ratings (with low uncertainty) to attributes related to label information, including nutritional value, availability of offers, expiration date, and nutritional content.

Price ranked the second, after taste, in terms of the low level of uncertainty in responses. Conversely, easy-to-open packaging was the attribute with the least importance for consumers and the highest level of uncertainty when assigning scores ($1 - \pi > 0.8$). The second least important attribute, after easy-to-opening packaging, is found to be brand knowledge.

Regarding the consumption motivations of PBBs [Figure 1(B)], the presence of vitamins and minerals has received the highest importance score and less uncertainty from consumers in assigning their judgment. The least common motivation, instead, is represented by "Healthy claims indicate that they can help prevent certain diseases".

The dissimilarity index falls within the range of 0 to 0.1 for all the considered characteristics, confirming that the estimated CUB model is a suitable methodology for the assumptions of this study. In general, the liking scores are all moderately high ($1 - \xi > 0.5$), confirming that the chosen attributes for this research are significant purchase drivers for PBBs consumers. Supplementary Materials Table A3 provides all the values for "feeling" (degree of importance) and uncertainty for the attributes considered.

3.3. The CUB (0, q) model

3.3.1. Sample socio-demographic characteristics as drivers of PBBs attribute perception

Among the socio-demographic characteristics considered as covariates in this study, the only significant results were the attributes of PBBs related to fat content, easy-open packaging and place of production. In particular, the results showed that women, individuals engaged in sports and with >55 years old were more attentive to the fat content of PBBs compared to the rest of the sample. Interestingly, contrary to expectations, for respondents without children, the place of production of PBBs is more important than for those with children. Tables A4-A7 in the supplementary materials provide more details.

3.3.2. Sample socio-demographic characteristics as drivers of PBBs consuming motivations

Socio-demographic characteristics considered in this study had a significant impact on the consumption motivations for this type of beverage, unlike the importance attributed to the PBB attributes.

Specifically, women demonstrated a propensity to consume PBBs for health-related reasons (Table 2). This is evident from their significantly higher importance ratings compared to men for the statements "they help improve health" and "they contribute to the maintenance of health" regarding the PBBs motivations of consumption. In contrast, among the men respondents, there is a tendency to consume PBBs for the benefits of their ingredients and to maintain a balanced diet.

When considering age as a covariate, participants aged over 45 years old expressed a higher level in all the selected motivations for consuming PBBs in this study (Table 3).

Participants without children assigned a higher degree of importance to the motivations for PBBs consumption compared to the interviewed consumers who are parents (Table 4).

Participants who engage in sports expressed significantly higher importance for all the analysed motivations for consuming PBBs (Table 5).

3.3.3. Sample certification-related eating style as driver of PBBs attributes perception

The results of the CUB models, estimated using certification-related eating style as a covariate, are reported in Table 6. The attribute considered significantly most important for all three certifications was taste, followed by the expiration date. It is interesting to note that the local/regional origin of the raw material is significantly more important (p -value < 0.001) for consumers who are mindful of organic certification in their food choices. Moreover, this type of consumers expressed a higher liking for attributes related to supply chain sustainability and packaging, compared to the rest of the sample. Furthermore, this group of consumers has indicated that nutritional content and fat content of PBBs are significantly more important, compared to the rest of the sample.

On the other hand, consumers attentive to local origin have assigned a higher degree of importance to the ethical certification of PBBs.

3.3.4. Sample eating habits as driver of PBBs attribute perception

The CUB model results, utilising eating habits as a covariate, are presented in Table 7. Consumers valuing food product quality assign significantly greater value to the place of production of PBBs, compared to the rest of the sample.

Instead, participants belonging to the group that prefers to consume fresh foods assign great importance to a significantly greater number of PBB attributes. In particular, the origin of PBB raw materials was assessed as the most important attribute (p -value < 0.01), followed by the nutritional content.

The group of calorie-conscious participants exhibited a significantly stronger preference, compared to other subjects in the sample, regarding the fat content, nutritional value, and label information related to the

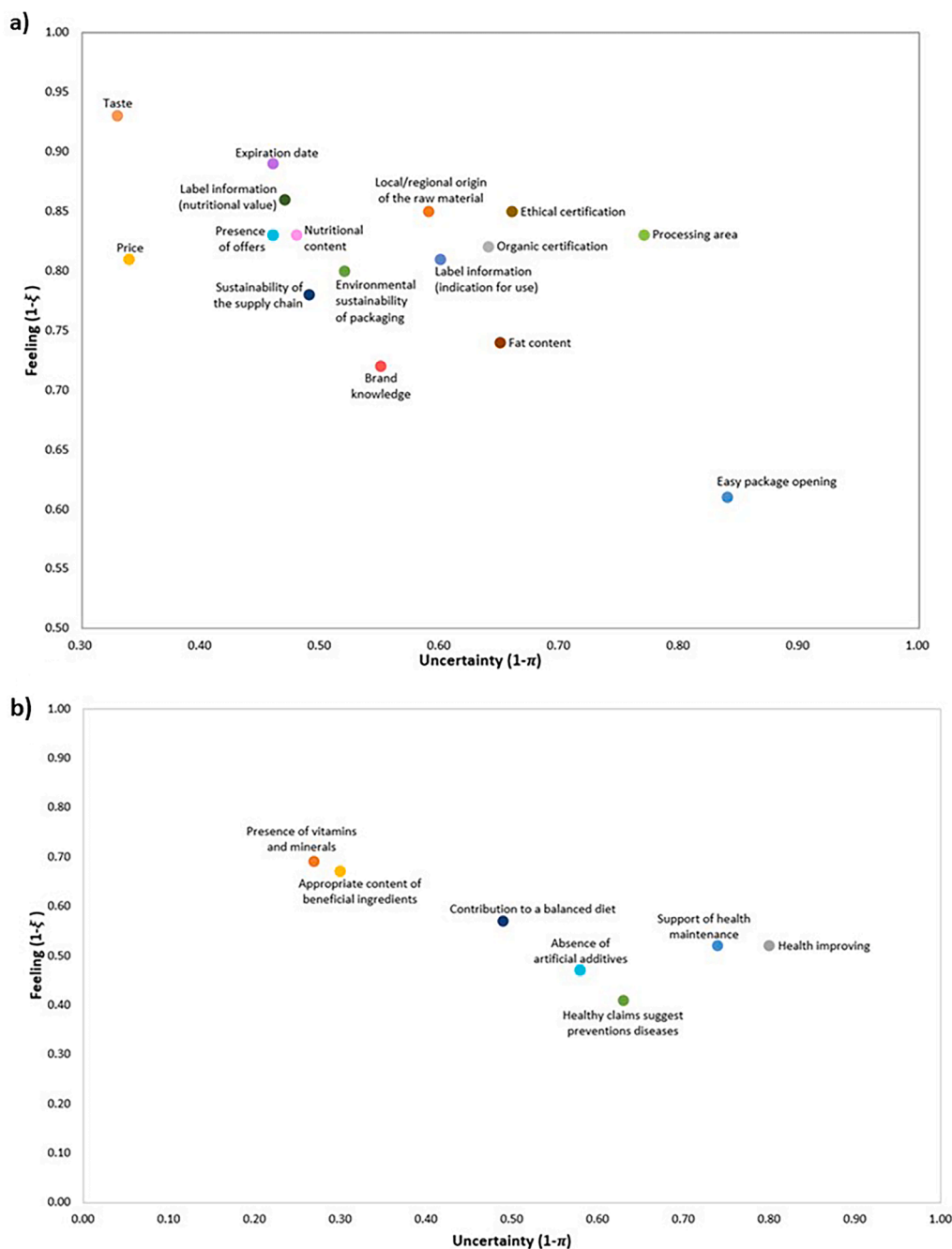


Fig. 1. (A) Representation of estimated levels of importance and uncertainty for PBBs consume motivations. (B) Representation of estimated levels of importance and uncertainty for PBBs consume motivations.

nutritional contents of PBBs. This result confirms that consumers who are mindful of the health and nutritional benefits of the products often choose PBBs as alternatives to cow’s milk.

4. Discussion

This research, using the CUB model approach, explored consumer preferences for 16 PBBs characteristics, categorised as credence, intrinsic and extrinsic attributes, and investigated the motivations driving their consumption. In addition, it examined how socio-demographic variables and consumption habits, as covariates of the model, influenced both these preferences and motivations.

The composition of the considered convenience sample is in line with the Puglia population data revealed by a census from 2021 (ISTAT,

2023), in particular with regard to the medium-high level of education and the balanced gender distribution.

The CUB (0,0) analysis, performed without covariates, showed that taste stood out from the other attributes, as consumers attached high importance to it and exhibited low uncertainty in their final decision. Indeed, several studies have demonstrated that the sensory properties of PBBs play a significant role in consumer choice, both as an alternative to cow’s milk and among the various plant-based raw materials used in formulations (Cardello et al., 2022; Liu et al., 2021). The findings of this study affirm the importance of taste as one of the key drivers for purchasing such products. Improving the sensory properties can, therefore, enhance the competitiveness and appeal of PBBs category in this market (Giacalone et al., 2022; Jaeger and Giacalone, 2021; Oduro et al., 2021; Sottile et al., 2023). Following taste, the sample assigned significant

Table 2
PBBs consume motivation by gender: estimation of CUB (0,1) models.

PBBs consume motivations	Uncertainty (1 - π)	Feeling (1 - ξ)	
		Men (\hat{y}_0)	Women (\hat{y}_1)
Presence of vitamins and minerals	0.28 (0.06)	0.67* (0.11)	0.72* (0.17)
Health improving	0.78 (0.08)	0.48*** (0.29)	0.59*** (0.49)
Appropriate content of beneficial ingredients	0.30 (0.07)	0.68* (0.11)	0.65* (0.17)
Support of health maintenance	0.74 (0.08)	0.50*** (0.22)	0.58*** (0.48)
Contribution to a balanced diet	0.49 (0.08)	0.58* (0.14)	0.56* (0.24)

Standard errors are indicated in parentheses;

* indicates p-value < 0.05,.

*** indicates p-value < 0.001.

importance scores to attributes related to expiration date, label information (nutritional values) and nutritional content. Nutritional profiling, in fact, represents the driving force behind the success of this emerging market segment (Grau-Fuentes et al., 2023). These plant-based alternatives often exhibit a less balanced nutritional profile compared to cow’s milk but contain components with health-beneficial properties that attract consumers (Sethi et al., 2016). On the other hand, the least important PBBs characteristics considered by the sample were the ease of opening the packaging and the brand knowledge. These findings are both in contrast with several studies in the literature that emphasise consumer appreciation for functional opening systems that enable easy resealing of the product and, thus, better preservation (Otto et al., 2021) and suggest that brand image is a discriminating factor in the selection of plant-based alternatives to cow’s milk (Boaitey and Minegishi, 2020; Haas et al., 2019).

Analysis of consumption motivations using the CUB (0,0) model revealed that the presence of vitamins and minerals was the most important purchase driver with the lowest level of uncertainty. This finding is consistent with the literature, which suggests that the content of these nutritional components represents one of the main purchase drivers for PBBs (Giacalone et al., 2022; Mastro Monaco et al., 2023).

Considering the influence of SD covariates on perception of PBBs attributes, the only significant results were related to the importance attached to fat content, easy-open packaging and processing area. Conversely, these consumers characteristics had a significant impact on their consumption motivations.

In particular, women attached significantly more importance than men to reasons related to improving and maintaining health. For men, on the other hand, the most important drivers were PBBs beneficial content and their contribution to a balanced diet. These findings are consistent with the literature, which suggests that women are the group that predominantly purchases foods with functional health properties, including PBBs, as they are more health-oriented in their dietary choices (Adamczyk et al., 2022; Baş et al., 2024; Cichońska and Ziarno, 2021). In

Table 3
PBBs consuming motivation by age: estimation of CUB (0,1) models.

PBBs consume motivations	Uncertainty (1 - π)	Feeling (1 - ξ)				
		18–25 years (\hat{y}_0)	26–35 years (\hat{y}_1)	36–45 years (\hat{y}_2)	46–55 years (\hat{y}_3)	Over 55 years (\hat{y}_4)
Health improving	0.80 (0.08)	0.53** (0.54)	0.48** (0.59)	0.41*** (0.57)	0.61** (0.56)	0.53** (0.57)
Support of health maintenance	0.74 (0.08)	0.55** (0.43)	0.49** (0.52)	0.45** (0.53)	0.58** (0.58)	0.51** (0.48)
Healthy claims suggest preventions diseases	0.63 (0.08)	0.42*** (0.33)	0.41*** (0.35)	0.32* (0.52)	0.34*** (0.53)	0.50*** (0.37)
Contribution to a balanced diet	0.49 (0.08)	0.58 (0.24)	0.52** (0.26)	0.54* (0.34)	0.58 (0.42)	0.62* (0.29)

Standard errors are indicated in parentheses; * indicates p-value < 0.05, ** indicates p-value < 0.01, *** indicates p-value < 0.001.

contrast, men exhibit particular attentions to the nutritional value of the foods they consume (Modlińska et al., 2020; Uliano et al., 2024).

The analysis of the influence of age on consumption motivations showed that older respondents attached greater importance to all PBBs drivers of consumption. In fact, as reported in previous studies, adults pay greater attentions to the nutritional information on labels and demonstrate a more pronounced interest in a healthy diet that includes foods with health benefits (Molinillo et al., 2020; Szakos et al., 2022; Uliano et al., 2024).

As highlighted in the literature, engaging in sport or not can influence the consumption of plant-based alternatives. Specifically, among individuals who participate in sports and seek protein-rich and

Table 4
PBBs consuming motivation by absence/presence of children: estimation of CUB (0,1) models.

PBBs consume motivations	Uncertainty (1 - π)	Feeling (1 - ξ)	
		Absence of children (\hat{y}_0)	Presence of children (\hat{y}_1)
Absence of artificial additives	0.54 (0.08)	0.58* (0.21)	0.41* (0.27)
Health improving	0.79 (0.08)	0.55*** (0.33)	0.48*** (0.51)
Support of health maintenance	0.73 (0.09)	0.54*** (0.29)	0.50*** (0.42)
Healthy claims suggest preventions diseases	0.60 (0.08)	0.50*** (0.28)	0.38*** (0.34)

Standard errors are indicated in parentheses;

* indicates p-value < 0.05,.

*** indicates p-value < 0.001.

Table 5
PBBs consuming motivation by not practice/practice sport: estimation of CUB (0,1) models.

PBBs consume motivations	Uncertainty (1 - π)	Feeling (1 - ξ)	
		Not playing sport (\hat{y}_0)	Playing sport (\hat{y}_1)
Absence of artificial additives	0.58 (0.08)	0.45** (0.24)	0.49** (0.30)
Health improving	0.74 (0.08)	0.24*** (0.72)	0.57*** (0.76)
Support of health maintenance	0.68 (0.08)	0.27** (0.45)	0.57** (0.49)
Healthy claims suggest preventions diseases	0.60 (0.08)	0.29* (0.35)	0.45* (0.39)
Contribution to a balanced diet	0.49 (0.08)	0.52* (0.22)	0.59* (0.26)

Standard errors are indicated in parentheses;

* indicates p-value < 0.05,.

** indicates p-value < 0.01,.

*** indicates p-value < 0.001.

Table 6
Consumers' preferences for PBBs attributes by certification-related eating styles: estimation of CUB (0,1) models.

Attributes	Uncertainty (1 - π)	Feeling (1 - ξ)		
		Organic certification	Local origin	Italian origin
Processing area	0.72 (0.07)	0.83 (1.21)	0.81 (0.80)	0.79 (0.88)
Local/regional origin of the raw material	0.59 (0.07)	0.85*** (0.56)	0.84 (0.60)	0.83** (0.76)
Brand knowledge	0.54 (0.07)	0.73 (0.36)	0.72 (0.57)	0.71 (0.64)
Price	0.33 (0.06)	0.82** (0.27)	0.81** (0.35)	0.82** (0.34)
Easy package opening	0.76 (0.07)	0.67** (1.66)	0.61 (3.96)	0.63* (2.76)
Environmental sustainability of packaging	0.45 (0.07)	0.82 (0.32)	0.80* (0.77)	0.80* (0.55)
Sustainability of the supply chain	0.46 (0.07)	0.80* (0.31)	0.78 (0.53)	0.78 (0.47)
Fat content	0.58 (0.07)	0.77** (0.34)	0.73** (0.62)	0.74** (1.50)
Expiration date	0.43 (0.06)	0.89** (0.48)	0.89* (1.38)	0.88*** (1.29)
Ethical certification	0.52 (0.06)	0.84 (0.44)	0.85* (1.20)	0.84 (1.13)
Presence of offers	0.45 (0.06)	0.83 (0.37)	0.82 (0.61)	0.83** (0.57)
Label information (nutritional value)	0.41 (0.06)	0.86** (0.35)	0.86** (0.74)	0.86** (1.20)
Label information (indication for use)	0.51 (0.06)	0.83** (0.36)	0.81 (0.69)	0.81 (0.83)
Taste	0.32 (0.05)	0.93** (0.45)	0.93** (0.65)	0.94*** (0.87)
Organic certification	0.62 (0.07)	0.84** (0.92)	0.82 (3.28)	0.81 (11.10)
Nutritional content	0.49 (0.06)	0.87** (0.67)	0.87 (0.99)	0.87 (0.69)

Standard errors are indicated in parentheses;.

* indicates p-value < 0.05,.

** indicates p-value < 0.01,.

*** indicates p-value < 0.001.

nutritionally balanced products, these alternatives are very common, with a strong focus on the nutritional and health aspects on their consumption (Birkenhead and Slater, 2015; Shaw et al., 2022). Our results are in line with these studies, in fact, participants who engage in sports expressed significantly higher importance for all the analysed motivations for consuming PBBs.

In order to investigate how participants' eating patterns influenced their perception of PBBs attributes, both dietary styles in relation to the importance attached to three types of certifications (organic, local origin and Italian origin) and eating habits (attention to calories, fresh food preference, focus on quality, focus on taste and nutrient-balanced diet) were considered.

The results on the influence of certification-related eating styles showed that consumers who prioritise organic certification places significantly more importance on the local/regional origin of the PBBs raw materials. In fact, studies on organic food preferences have highlighted how certain consumer types correlate their preference for organic certification with a preference for local production. These two characteristics are linked to the concept of territorial ties driven by an interest in supporting local producers and environmental sustainability (Birch et al., 2018; Bojnec et al., 2019; Varaldo et al., 2022). In addition, organic-addicted participants placed significantly more weight on nutritional and fat content than the rest of the sample. Indeed, some consumers who choose organic products associate them with higher nutritional quality and health benefits, especially concerning plant-based products (Chae et al., 2024; Daraboina et al., 2024; Nagaraj,

2021). Another interesting finding from this analysis is the importance that local-mindful consumers attached to the presence of ethical certification on PBBs labels. Indeed, the preference for local origin is linked to concepts of supporting local producers and workers and the local economy (Kumar et al., 2021).

In addition, considering the influence of dietary habits on PBBs preferences, it was found that consumption profiles analysed had a significant impact on consumers' perception of this type of product. Almost all profiles showed significant differences in preference. In particular, consumers who focus on product quality attached significantly more importance to PBBs processing area. In fact, food product quality is often associated with food supply chain safety and transparency. Label information regarding the place of production, as well as the origin of raw materials, influences consumers' judgment during the purchasing phase (Aizaki and Sato, 2020; Atallah et al., 2021).

The sample group that prefers fresh foods showed heightened attention to the local origin of the PBBs raw materials, placing a higher importance on this factor than the rest of the sample. This finding can be linked to existing literature suggesting that local origin is often associated with product freshness and streamlining production processes (Kumar et al., 2021). Another driver for choosing fresh foods is the perception of better nutritional content (Wang and Tsai, 2019). Our study's results indicated that, for the group accustomed to consuming fresh foods, nutritional content is the second most significantly important factor. This attribute, along with fat content, was found to be the most important for consumers who are mindful of maintaining a nutritionally balanced diet. In fact, PBBs are perceived as more nutritionally balanced and with lower fat content (McCarthy et al., 2017b; Moss et al., 2022; Sridhar et al., 2022).

However, this study is affected by a limitation given by the small convenience sample size and a narrow geographical area. Indeed, the explored area is a highly relevant context for the study of PBBs, as it is the second most important region in Italy for almond production. Given the regional importance of almond cultivation, consumers in this area are a suitable target population for understanding preferences within this specific market segment. In future research, to compare samples with different eating habits and socio-demographic characteristics, a larger Italian sample and different geographical areas should be considered.

5. Conclusion

This study allowed us to define differences in PBBs perceptions among a sample of Italian consumers in terms of nutritional quality, certifications (organic, sustainability, ethics), sensory aspects, and label information. The results suggest that Italian consumers consider taste as the most important attribute in the PBBs consumption choice, followed by the expiration date and nutritional content. Additionally, the attribute "easy to open" is the one they judge with the most uncertainty. Socio-demographic characteristics do not significantly influence most of the attributes of PBBs, except for easy-to-open packaging, fat content and production area. In particular, women, individuals over 55 years old, and those without children in the household have expressed a higher liking for these attributes. Conversely, certification-related eating styles and food habits significantly influence consumers' choice of the most important PBBs attributes. Therefore, the PBBs purchase drivers vary depending on consumption habits and the importance each consumer places on product certifications. For instance, consumers who value organic certification place greater importance on the local/regional origin of the raw materials used in the plant-based drink and its nutritional content.

On the other hand, considering the PBBs consumption motivations, the consumer socio-demographic characteristics significantly influenced the responses. For instance, women and older individuals tend to consume vegetable drinks due to the potential health benefits of their ingredients.

Table 7
Consumers' preferences for PBBs attributes by eating habits: estimation of CUB (0,1) models.

Attributes	Uncertainty (1 - π)	Feeling (1 - ξ)				
		Attention to calories	Fresh food preference	Focus on quality	Focus on taste	Nutrient-balanced diet
Processing area	0.75 (0.07)	0.85 (0.57)	0.83 (0.82)	0.87* (0.63)	0.84 (0.61)	0.89 (0.58)
Local/regional origin of the raw material	0.58 (0.07)	0.86 (0.37)	0.87** (0.46)	0.88 (0.38)	0.85 (0.38)	0.88 (0.37)
Brand knowledge	0.53 (0.07)	0.76 (0.27)	0.74 (0.29)	0.75 (0.29)	0.72 (0.28)	0.78 (0.29)
Price	0.33 (0.06)	0.82* (0.22)	0.81** (0.25)	0.82 (0.24)	0.84* (0.22)	0.85 (0.22)
Easy package opening	0.81 (0.07)	0.71** (0.56)	0.63 (1.04)	0.65* (0.72)	0.64** (0.58)	0.70* (0.67)
Environmental sustainability of packaging	0.50 (0.07)	0.85 (0.30)	0.82* (0.33)	0.81 (0.32)	0.81 (0.31)	0.85 (0.32)
Sustainability of the supply chain	0.47 (0.07)	0.81 (0.26)	0.80* (0.29)	0.80 (0.28)	0.80 (0.26)	0.81 (0.26)
Fat content	0.53 (0.07)	0.86* (0.33)	0.78** (0.41)	0.80 (0.39)	0.72 (0.41)	0.80* (0.42)
Expiration date	0.47 (0.06)	0.80 (0.34)	0.89** (0.42)	0.90* (0.39)	0.91 (0.32)	0.88 (0.36)
Ethical certification	0.65 (0.06)	0.88 (0.43)	0.87* (0.45)	0.89 (0.44)	0.85 (0.44)	0.89 (0.46)
Presence of offers	0.45 (0.06)	0.84 (0.29)	0.83* (0.34)	0.85 (0.29)	0.85 (0.28)	0.86 (0.27)
Label information (nutritional value)	0.42 (0.06)	0.89* (0.27)	0.88* (0.30)	0.88 (0.30)	0.82 (0.30)	0.89 (0.29)
Label information (indication for use)	0.58 (0.07)	0.84* (0.32)	0.85** (0.34)	0.83 (0.35)	0.79 (0.33)	0.87 (0.34)
Taste	0.32 (0.05)	0.93* (0.35)	0.93** (0.44)	0.92* (0.48)	0.95* (0.35)	0.94 (0.33)
Organic certification	0.62 (0.07)	0.88* (0.40)	0.83* (0.44)	0.85 (0.43)	0.81 (0.41)	0.87 (0.40)
Nutritional content	0.43 (0.06)	0.90** (0.29)	0.89** (0.32)	0.89 (0.31)	0.86 (0.34)	0.91* (0.30)

Standard errors are indicated in parentheses;

* indicates p-value < 0.05,

** indicates p-value < 0.01.

In conclusion, profiles of PBBs consumers can be distinguished according to their characteristics and eating habits. This aspect is important for companies producing and marketing such products to understand the needs of their target consumers in order to meet their requirements effectively.

This paper contributes to the literature with tangible implications for production, marketing communication strategies and targeted value decisions for PBBs. Moreover, this work allows the identification of consumer profiles based on different aspects, considering not only the intrinsic, extrinsic and belief characteristics of PBBs, but also the consumption motivations that are increasingly driving consumers to consider this alternative to cow's milk.

CRediT authorship contribution statement

Giulia Mastro Monaco: Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis, Data curation, Conceptualization. **Stefano Massaglia:** Writing – review & editing, Validation, Supervision, Methodology, Data curation, Conceptualization. **Danielle Borra:** Writing – review & editing, Supervision, Methodology. **Francesco Sottile:** Validation, Supervision, Resources, Project administration, Conceptualization. **Cristiana Peano:** Supervision, Resources, Methodology, Conceptualization. **Mingze Rui:** Writing – original draft, Software, Methodology, Formal analysis. **Oriana Mosca:** Writing – review & editing, Methodology, Investigation. **Valentina Maria Merlino:** Writing – review & editing, Visualization, Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical statement

Approval for the involvement of human subjects in this study was granted by the University Bioethics Committee of the University of Turin (protocol number 0202725, 13/04/2022). The study was explained to consumers in the online questionnaire. They were informed that they would participate in the survey using their personal smartphone and that all data will be de-identified and only reported in the aggregate. All participants acknowledged an informed consent statement in order to participate in the study.

Data availability statement

Data sharing is not applicable to this article due to privacy.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.fufo.2025.100625](https://doi.org/10.1016/j.fufo.2025.100625).

Data availability

Data will be made available on request.

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