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# Does label information reflect product properties? A Swiss case study of plant-based milk alternatives

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ABSTRACT

Front-of-pack labels are recognised as an important tool in guiding consumers towards healthier product choices. However, an overwhelming variety of labels can also lead to misleading label information. This is particularly the case for newer product categories, such as plant-based milk alternatives, where strict marketing regulations are lacking. To improve the consumer friendliness of front-of-pack labels, more in-depth label information is needed. The first aim of this study was therefore to investigate the number and types of front-of-pack labels for plant-based milk alternatives in the Swiss market. Second, we aimed to better understand whether label information reflects product properties. Therefore, we investigated the congruence between the label information of a product and its nutritional, compositional, and price properties. To this end, we conducted a comprehensive online market inventory to collect information from product packaging. For all products, the Nutri-Score for plant-based milk alternatives was calculated using the Rayner-Score method. Principal component analysis was used to analyse correlations between label information and product properties (i.e. nutrition, composition, price). A total of 327 labels were identified among the 66 plant-based milk alternatives, reflecting a high degree of heterogeneity. Nutrition labels (34 %) (i.e. 'kcal per 100 ml', 'no added sugar', or 'Nutri-Score') and diet labels (29 %) (i.e. 'vegan' or 'plant-based') were used more often than sustainability labels (11 %) (i.e. 'organic', 'climate footprint', or 'fairtrade'). Moreover, we found that products with 'Nutri-Score' or 'climate footprint' labels were more expensive. We conclude that 'high protein', 'low fat', and 'low price' labels reflect the nutritional value or price of the product. However, the 'no added sugar' label could potentially mislead consumers, as products with this label had a similar sugar content to products without this label. We also found that the lower the nutritional quality of a product, the less often the Nutri-Score was illustrated on the products. This study identified strategies that could improve the consumer friendliness of labels for plant-based milk alternatives. This might contribute to stricter labelling policies and more effective labelling in the future.

## 1. Introduction

In recent years, plant-based milk alternatives (hereafter referred to as milk alternatives) from various plant sources (e.g. oats, rice, and almonds) have become increasingly popular among consumers. This change was driven by lifestyle, health, and growing awareness of sustainable dietary choices (Ammann et al., 2023; FOAG, 2022; Munekata et al., 2020; Runte et al., 2024; Vaikma et al., 2021). Milk alternatives are an interesting product category to help transform the food system towards a more sustainable and healthier environment, given their lower environmental impact compared to animal-based products (Poore & Nemecek, 2018). In addition, shifting dietary patterns towards more plant-based options could have positive benefits for cardiovascular health (Bruns et al., 2024).

Although milk alternatives have potential health and environmental benefits, nutritional and compositional quality varies widely between products and sometimes even between products from the same plant source (Aydar et al., 2020; Chalupa-Krebzdak et al., 2018; Scholz-Ahrens et al., 2020; Walther et al., 2022). Thus, in addition to plant sources, processing and formulation influence the nutritional profile of milk alternatives (Reyes Jurado et al., 2021). Consequently, consumers may find it difficult to make informed purchasing decisions. Simplified and transparent product information through front-of-pack labels (hereafter referred to as labels) can help consumers make informed, healthy, and sustainable dietary choices (Asioli et al., 2017; Brandt et al., 2010; Duckworth et al., 2022;Eufic, 2022; FAO, 2024; Kühne et al., 2022;

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Muzzioli et al., 2022; Narciso& Fonte, 2021). Labels can appear as symbols, letters, colour codes or graphical formats, tags, brands, marks, pictorial, or other descriptive phrases, such as claims (e.g. 'high in protein').

However, label information should be easily understandable to allow consumers to compare alternative products (Futtrup et al., 2021). In particular, among more novel products, such as milk alternatives, strict marketing regulations are often absent, which might contribute to misleading labels (Goiana-da-Silva et al., 2019; Muzzioli et al., 2022). Indeed, research has shown that a proper understanding of food labels is challenging for consumers (Goiana-da-Silva et al., 2019) and that too much information on the packaging front can trigger confusion and misinterpretation (Folwarczny et al., 2024; Nestle & Ludwig, 2010; Petersen et al., 2021). Consequently, label information might become ineffective for consumers, as too much and inconsistent information between products can hinder the comparison of alternative products (Futtrup et al., 2021). Thus, scholars have highlighted the need for more policies and guidance regarding front-of-pack labelling (Goiana-da-Silva et al., 2019). This is particularly relevant, as consumers use the label information as a proxy to compare products with each-other (Futtrup et al., 2021), and products with a specific label information evoke different expectations than products without such information.

Research on milk alternatives and their labelling remains limited. Most existing studies have focused on nutrition or organic labels, particularly within the Italian and Spanish markets (Angelino et al., 2020; Pérez-Rodríguez et al., 2023; Rodríguez-Martín et al., 2023). One such study evaluated the accuracy of the nutritional content of milk alternatives in Italy (Lo Turco et al., 2023). Additionally, two studies have examined consumer perceptions of labels in the USA and South Korea (Baptista & Schifferstein, 2023; Lee et al., 2024). To date, only one study has investigated various label types for milk alternatives specifically within the Italian market (Mastromonaco et al., 2023). Notably, none of these studies have exclusively focused on front-of-pack labels. Furthermore, several scholars have emphasized the need for easily understandable labels to help consumers make informed food choices (Angelino et al., 2020, 2019; Pérez-Rodríguez et al., 2023).

To provide a basis for a more binding and harmonised food policy, more knowledge about the labels on the front of the packaging of plant-based milk alternatives is needed. A recent study showed that a market inventory of commercial products is useful for analysing the in-depth nutritional and compositional properties of products (Liechti et al., 2022). Further, a better understanding of whether label information reflects product properties is useful for identifying potentially misleading labels. Product price is another relevant piece of information due to increased consumer attention (Pachali et al., 2023; Rao et al., 2013; Szakál et al., 2023).

As in other countries, milk alternatives have become increasingly popular in Switzerland over the last few decades (Ammann et al., 2023; FOAG, 2022; Runte et al., 2024). Since 2017, the demand for milk alternatives has steadily increased, particularly for oat products (FOAG, 2022). Some projects have also shown that plant-based alternatives could be an interesting growth market for Swiss agriculture (Ammann et al., 2024). Thus, milk alternatives are particularly interesting because they contribute to a more sustainable diet and environment.

This study contributes to the literature with the following two aims: first, we aimed to investigate the number and types of labels on the front of the pack for plant-based milk alternatives in the Swiss market. Second, we aimed to better understand whether the information on the labels reflects the product's properties. Therefore, we investigated the congruence between the label information of a product and its nutritional, compositional, and price properties. Label information and product properties, such as nutrient content, composition, and price, were retrieved from the packaging on the websites through a comprehensive market inventory of commercial milk alternatives. To analyse the multidimensional data, we applied a multi-criteria mapping approach in which label information (i.e. nutrition, absence of allergens, product property, environmental sustainability, social sustainability, price, origin, and diet) was mapped together with product properties (i.e. nutrition, composition, and price). We then analysed the correlations of the outcomes.

## 2. Materials and methods

This study involved three steps, as shown in Fig. 1. First, a comprehensive online market inventory of milk alternatives in Switzerland was conducted to collect data on label information, nutritional value, compositional value, and price of the products. Second, we analysed the number and types of labels on the front of the packages. Third, to investigate whether label information reflects product properties (i.e. nutrition, composition, and price), we performed a multi-criteria mapping and analysed correlations using a principal component analysis (PCA).

### 2.1. Online Swiss market inventory on plant-based milk alternatives

Market inventories are useful for gathering detailed commercial product information (Liechti et al., 2022). Therefore, products available on the Swiss online market in 2023 (May–July) were considered for this study. The information was retrieved from three supermarkets in Switzerland, which are among the supermarkets with the largest online food offerings (see **Supplementary Table 1**). Label information (front-of-pack), nutritional and compositional properties, and the price of the products were retrieved from the product packaging. Label information, if available in German, was translated into English. Further, prices were converted from Swiss francs to Euros. The Nutri-Score (green letter A [highest nutritional quality] to red letter E [lowest nutritional quality]) was calculated based on the Rayner computation (Rayner-Score) for each product using the beverage algorithm (Rayner, 2017; Santé publique France, 2023).

### 2.2. Analysis of the number and type of labels

We developed a label classification scheme based on previous research to analyse the label types (see Table 1). Our scheme considers eight different types: (1) nutrition, (2) absence of allergens, (3) origin, (4) environmental sustainability, (5) diet, (6) product property, (7) social sustainability, and 8) price.

### 2.3. Analysis of the correlations between label information and product properties

To better understand whether label information reflects product properties, we performed a multi-criteria mapping with a total of 36 quantitative variables (see Fig. 2). Due to the low presence of six nutrition labels (% protein, % almond, % fat, with bourbon vanilla extract, low in natrium, contains naturally sugar), which were grouped as 'other labels', they were not included in the multi-criteria mapping.

The composition variable '% non-processed plant sources' refers to the main plant source (e.g. from cereals [oat, rice], legumes [soy, pea], nuts [almond, coconut, hazelnut, cashew], or tuber [potato]). The composition variable '% processed plant sources' considers plant sources that have been added to the product in an already processed condition, such as flours, powders, pastes, extracts, or protein isolates. Furthermore, the composition variable 'number total ingredients' reflects the complete ingredient list with ingredients (e.g. water, sugar, and oil), additives, aroma, minerals and trace elements, vitamins, and enzymes retrieved from the ingredient list.

#### 2.3.1. Statistical analysis for correlations

For multi-criteria mapping, we used XLSTAT version 2023.1.6 (1410) (Addinsoft, New York, USA). In total, 63 milk alternatives were included in the statistical analysis due to three missing values for the

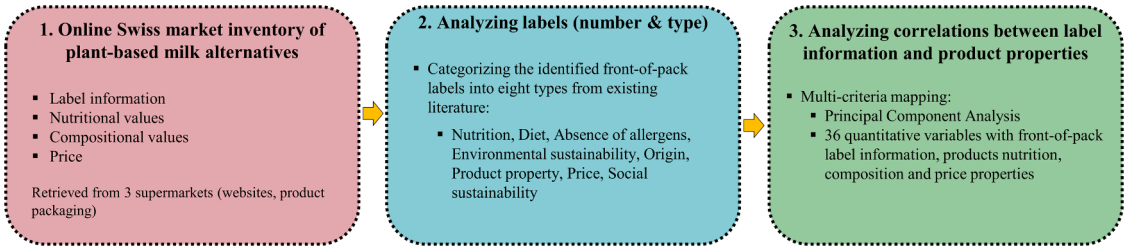


**Fig. 1.** Overview of data collection and the methods used.

**Table 1**
An overview of the label classification scheme.

| Label type | Examples of front-of-pack labels | Description | Authors |
|---|---|---|---|
| 1. Nutrition | Nutri-Score | Provides nutrition information to consumers. The Nutri-Score refers to a product's nutritional quality by considering favourable nutrients/ingredients and nutrients/ingredients to limit. | Merz et al., 2024, Rayner, 2017, Santé publique France, 2023 |
| | Guideline daily amount (GDA) and Reference Intake (RI%). | Provides information about product's nutritional values per 100 g/100 ml and or per portion with each amount representing as a % of an average person's daily dietary reference intake. | Food Drink Europe, 2021 |
| | Nutrition content claims: 'Low in…', 'High in…', 'No added sugar, salt', etc. | Promotes beneficial nutritional characteristics of the product or the limiting or absence of a specific ingredients. | Croker et al., 2020 European Commission, 2024a |
| 2. Absence of allergens | Soy-free, Dairy-free, Gluten-free, Lactose-free etc. | Refers to allergens which are absent in the product and could cause allergic reactions. | European Commission, 2024b, FDA, 2013, Katidi et al., 2022 |
| 3. Origin | 'Produced in…', 'Oat from…' etc. | Provides the origin of product's production, the origin of an ingredient or a specific geographical region. | European Commission, 2024c; Santeramo & Lamonaca, 2020 |
| 4. Environmental sustainability | Climate footprint | Refers to beneficial environmental characteristics of food products, e.g. the cultivation, production, packaging, distribution etc. or they can indicate the total greenhouse gas emission caused by the food product. | Kühne et al., 2023, Lemken et al., 2021 |
| | Organic | Refers to strict conditions for products production and processing, transport and storage. | European Commission, 2024d, Janssen & Hamm, 2012 |
| 5. Diet | Plant-based, Vegan | Promotes a special diet (e.g. only composed of plant sources, free of any animal products) or so called 'clean labels'. | Noguerol et al., 2021, The Vegan Society, 2022 |
| 6. Product property | Creamy, Crunchy, Foamable etc. | Indicates product characteristics to emphasise a specific benefit of a product. | Maarel, 2020 |
| 7. Social sustainability | Fairtrade | Promotes products from fair trades, who take into account certain social, ecological and economic criteria. | Berry & Romero, 2021, Liu, 2010 |
| 8. Price | Low price | Promotes short-term or long-term reduced prices for a specific product compared to similar products on the market, intended to attract consumers' attention. | Chang et al., 2024; Waterlander et al., 2013 |

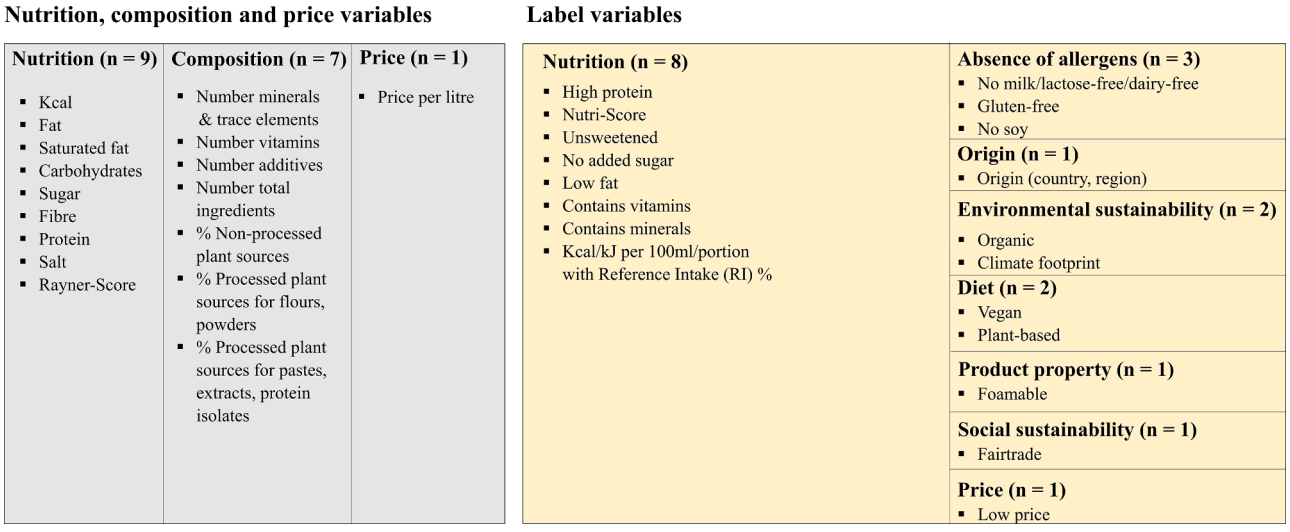


**Fig. 2.** Overview of the 36 quantitative nutrition, composition, price, and label variables for the PCA. From the left to the right, the variables for product nutrition (nutritional values in g per 100 ml and computed Rayner Score) ($n = 9$), composition ($n = 7$), and price per litre (in Euro) ($n = 1$). Label variables for nutrition ($n = 8$), absence of allergens ($n = 3$), origin ($n = 1$), environmental sustainability ($n = 2$), diet ($n = 2$), product property ($n = 1$), social sustainability ($n = 1$), and price ($n = 1$).

composition variable '% non-processed plant source', which were excluded. Furthermore, other nutrition labels that were identified only in low numbers were not included in the analysis (see Section 2.3).

We performed a PCA with a total of 36 quantitative variables on a correlation matrix. Supplementary variables were plotted only after the PCA computation. PCA is an appropriate method when dealing with multidimensional data in order to examine the correlations between variables (loadings) and samples (scores) (Alkarkhi & Alqaraghuli, 2019; O'Sullivan, 2017). For the PCA, we used the Pearson correlation coefficients with a significance level alpha = 0.05 with standardised data, while missing data were not included. For the validation axes, axes F1–F2 were considered.

We included a total of 21 active variables in the PCA: 8 active nutrition labelling variables (*high protein, Nutri-Score, unsweetened, no added sugar, low fat, contains vitamin, contains minerals, kcal/kj per 100 ml/portion*), 7 active nutrition variables (*fat, saturated fat, carbohydrates, sugar, fibre, protein, and salt content*), *and* 6 active composition variables (*number of minerals/trace elements, number of vitamins, number of additives, % non-processed plant sources, % processed plant sources [flour, powder], % processed plant-sources [pastes, extracts, protein isolate]*). Besides the active variables, we included 15 supplementary variables in the PCA: all 11 label variables (*vegan, plant-based, no milk/lactose-free/dairy-free, gluten-free, no soy, origin, organic, climate footprint, fairtrade, foamable, and low price),* 1 price variable (*price per litre*). Further, as the variables for the *kcal*, the *Rayner-Score* and the *total ingredients* are not independent within the correlation matrix, they were further treated as supplementary variables within the PCA correlation matrix.

## 3. Results

### 3.1. Database

Our database included 66 milk alternatives from 14 different brands (7 national, 7 international) and 10 different plant sources. Oat ($n = 25$) and soy products ($n = 10$), including milk alternatives with mixed plant sources (rice, hazelnut, almond, coconut, cashew nut, soy, oat, quinoa, spelt, barley, and wheat) ($n = 10$), were most frequently observed. Milk alternatives from rice ($n = 6$), almond ($n = 5$), potato ($n = 3$), hazelnut ($n = 2$), pea ($n = 2$), coconut ($n = 2$), and cashew ($n = 1$) were less common in the commercial market. Among the 66 products, a large heterogeneity in nutritional values and composition was observed. **Supplementary Table 2** provides detailed nutritional and compositional information for all 66 products included in the database.

### 3.2. Number and types of labels

The majority of the products illustrated three or six labels on the front of the pack, with a minimum of one and a maximum of nine labels (see Fig. 3). Furthermore, 11 products had multiple labels with identical information. Specifically, seven products illustrated the 'vegan' label three times, while three products displayed the 'no added sugar' label twice on the front-of-pack.

A total of 20 different labels were identified on the 66 products (see Fig. 4). The most frequently used labels on front-of-pack were 'vegan' (21 %), 'no milk, lactose-free or dairy-free' (13 %), 'kcal, kj per 100 ml and or portion with RI%' (10 %), 'organic' (10 %), 'no added sugar' (10 %) and plant-based (7 %). The 'no added sugar' label was thus more often used than the 'unsweetened' (2 %) label. The least frequently illustrated labels were 'high protein' (0.5 %), 'fairtrade' (1 %), 'no soy' (1 %) and 'contains mineral' (1 %) (calcium). Labels claiming to contain vitamins illustrated Vitamin D, Vitamin B12, Vitamin B2 or more generic as vitamin only. Further, about 20 % of the products illustrated the Nutri-Score on the front-of-pack.

After grouping the labels into the eight label types (see Table 1), we found that nutrition labels (coloured in blue) accounted for the highest percentage (34 %), followed by diet labels (coloured in yellow) (29 %) and labels indicating the absence of allergens (coloured in light orange) (18 %). Labels relating to environmental sustainability (coloured in green) (11 %), origin (coloured in grey) (most of the labels referred to the country of the ingredient origin while only one label referred to the country of production origin) (4 %), product property (coloured in purple) (2 %), price (coloured pink) (1 %), and social sustainability (coloured in dark orange) (1 %) were less common. Other labels in Fig. 4 were illustrating following information: % fat, % almond, % protein, contains naturally sugar, low in natrium and with bourbon vanilla extract.

We further found that products based on oat, soy, hazelnut, and cashew applied predominantly nutrition labels (see Fig. 5). By contrast, products based on almonds displayed more origin and diet labels, while potato and coconut products had the highest number of 'absence of allergens' and diet labels. Further, almond milk alternatives had the highest number of sustainability labels.

A 'Nutri-Score' label was predominantly found on oat-based milk alternatives, while it was never on rice, soy, pea, almond, and coconut products. However, we found that rice-based milk alternatives had overall a higher Nutri-Score compared to other products from the market and the highest average sugar content (4.9 g ± 2.2 g per 100 ml). Moreover, labels claiming fortification with vitamins and minerals were

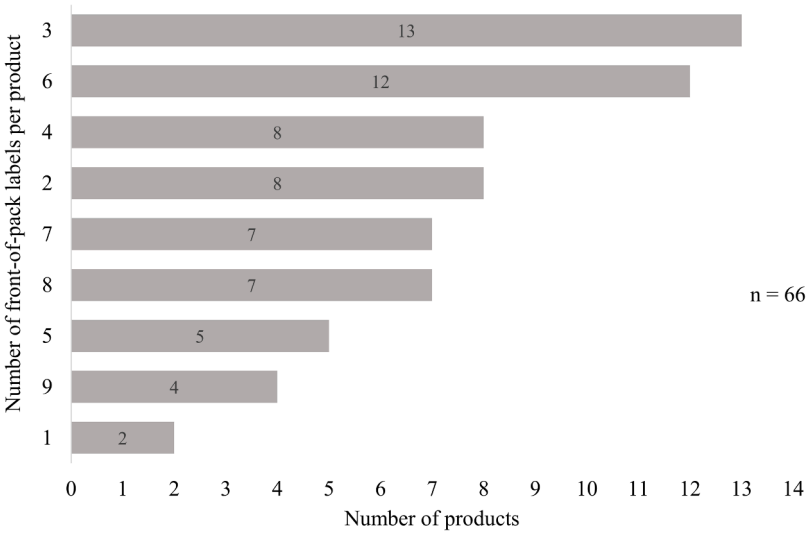


**Fig. 3.** Number of labels per product on plant-based milk alternatives ($n = 66$).

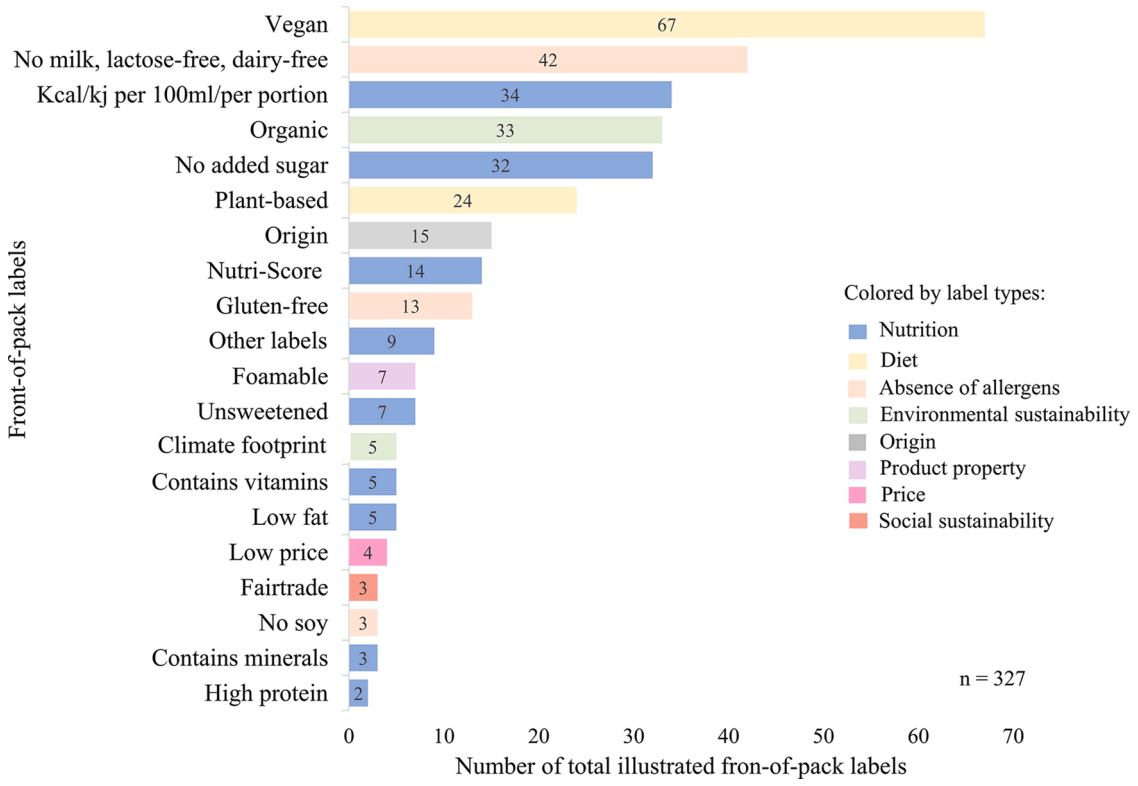


**Fig. 4.** Total number of different labels and the corresponding label type for the 66 products. 'Other labels' are the following less-represented nutrition labels: % protein, % almond, % fat, with bourbon vanilla extract, low in natrium and contains naturally sugar.

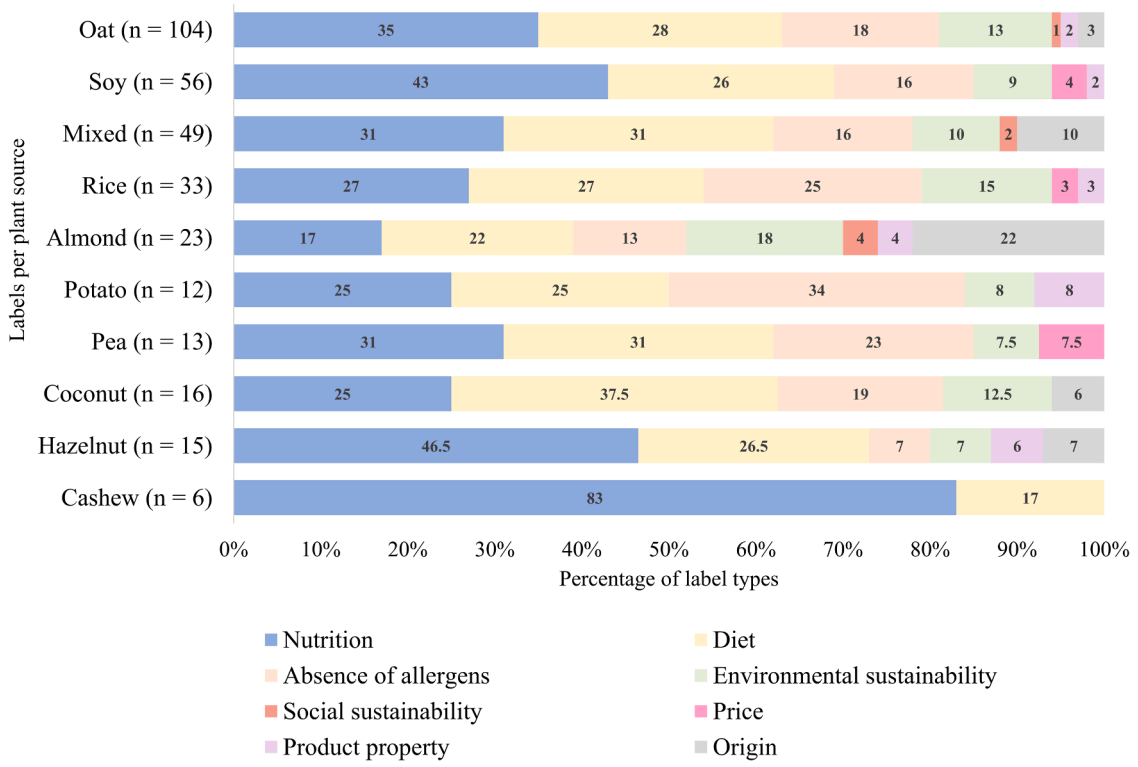


**Fig. 5.** Plant sources of the products and types of labels ($n$ = 327 on 66 plant-based milk alternatives) for oat, soy, mixed, rice, almond, potato, pea, coconut, hazelnut, and cashew. The labels are coloured based on eight different label types.

mainly found on soy-based milk alternatives. Mixed plant source products were most frequently labelled as gluten-free, while the origin label was especially found on almond milk alternatives. Finally, low price labels were only found on rice, soy, and pea products.

### 3.3. Correlations between label information and product properties

We performed a PCA of 36 quantitative variables (with alpha = 0.05 as the significance level) to investigate whether label information reflected product properties. Therefore, axes F1–F2 were considered, as they included with 31.02 % the largest explained variability. An overview of all correlations among nutrition, composition, labelling, and price variables is provided in **Supplementary Tables 3, 4,** and **5.** The loadings in Fig. 6 (axes F1–F2) present the correlations between 21 active (7 nutritional values, 6 composition values, and 8 nutrition labels) and 15 supplementary (other label types [11], total ingredients [1], kcal and Rayner-Score [2], and price [1]) variables.

A significant positive correlation occurs when two variables are far from the centre and closely aligned (moving in the same direction) (r close to 1). Conversely, a significant negative correlation is observed when two variables move in opposite directions of the centre (r close to −1). When two variables are orthogonal, there is no correlation between them (r close to 0).

#### 3.3.1. Correlations between nutrition label information and the nutritional properties of the products

Focusing first on significant correlations between nutrition labels and nutritional properties of the products, we found that products labelled with 'high protein' and 'low fat' were associated with a higher protein content ($r = 0.428$), and a lower fat content ($r = -0.315$) compared to products without such a label. Next, when comparing products labelled 'high protein' and 'low fat' with those without (see Table 2), we found a higher mean protein and a lower mean fat content in the labelled products compared to those without.

Further, milk alternatives with the label 'unsweetened' were associated with a lower kcal ($r = -0.467$), carbohydrate ($r = -0.379$), and sugar content ($r = -0.349$) while having a lower Rayner-Score ($r = -0.490$) compared to products without such a label. Again, the products labelled 'unsweetened' had a lower mean sugar content than milk alternatives without such a label (see Table 2). Interestingly, products with the label 'no added sugar' were not associated with a lower sugar content, but with a reduced fat ($r = -0.326$) and kcal ($r = -0.320$) content while showing a lower Rayner-Score ($r = -0.297$) instead. Indeed, milk alternatives labelled with 'no added sugar' had almost a

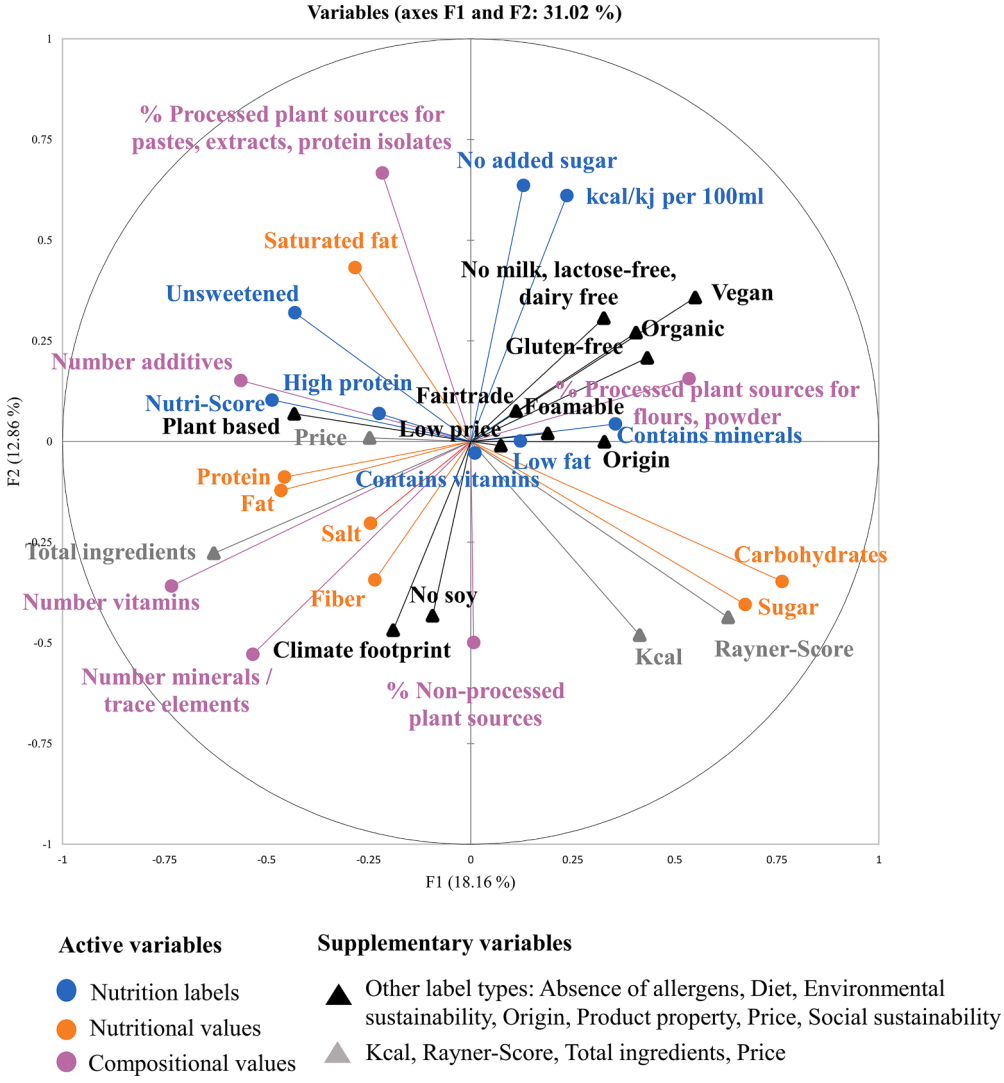


**Fig. 6.** Principal component analysis (PCA) with axes F1 and F2 and the correlation matrices with a total of 36 quantitative variables (21 active variables such as nutritional values in orange colour and composition in purple colour; 15 supplementary variables such as other label types in black colour and kcal, Rayner-Score, total ingredients and price per litre in grey colour) from 63 plant-based milk alternatives.

**Table 2**
Label congruency, comparison of products with and without nutrition/price labels in terms of their mean nutritional values and price.

| Label variable | Nutrition and price variable | Significant correlation ($p < 0.05$); Yes or No | Mean nutritional values in g/100 ml and price in Euro with SD ± | | Number of products |
|---|---|---|---|---|---|
| High protein | Protein content | Yes ($r = 0.428$) | With 'high protein' label | 3.4 ± 0.6g | $n = 2$ |
| | | | Without 'high protein' label | 1 ± 0.9 g | $n = 61$ |
| Unsweetened | Sugar content | Yes ($r = -0.349$) | With 'unsweetened' label | 1 ± 2.7 g | $n = 7$ |
| | | | Without 'unsweetened' label | 3.5 ± 2 g | $n = 56$ |
| Low fat | Fat content | Yes ($r = -0.315$) | With 'low fat' label | 1.1 ± 0.4 g | $n = 5$ |
| | | | Without 'low fat' label | 2 ± 0.8 g | $n = 58$ |
| No added sugar | Sugar content | No | With 'no added sugar' label | 3.2 ± 2.5 g | $n = 28$ |
| | | | Without 'no added sugar' label | 3.5 ± 2 g | $n = 35$ |
| Low price | Price | Yes ($r = -0.486$) | With 'low price' label | 1.8 ± 0.2 Euro | $n = 4$ |
| | | | Without 'low price' label | 3.2 ± 0.6 Euro | $n = 59$ |

similar mean sugar content compared to products without that label (see Table 2).

We also found that products with a Nutri-Score label tended to have lower sugar ($r = -0.266$) and higher fibre ($r = 0.320$) content. Not surprisingly, the Nutri-Score label was less frequently observed on products with a higher Rayner-Score (and consequently Nutri-Score letter D or E) and therefore poorer nutritional quality. In addition, products with the labels 'contains vitamin' or 'contains minerals' were both associated with a lower salt content ($r = -0.353$ and $r = -0.373$, respectively), while products labelled with 'contains minerals' tended to have a lower fat content ($r = -0.282$). Lastly, products with a label indicating the kcal or kj per 100 ml or portion tended to have a lower fibre content ($r = -0.267$).

#### 3.3.2. *Correlations between nutrition and price label information and the composition and price properties of the products*

Our analysis of the correlations between label information and product composition revealed several significant correlations. We found that milk alternatives with a Nutri-Score label contained a higher number of additives ($r = 0.534$), total ingredients ($r = 0.422$), and vitamins ($r = 0.331$). The same was observed for products labelled 'unsweetened', which were associated with an increased number of vitamins ($r = 0.358$), additives ($r = 0.272$), and total ingredients ($r = 0.291$). Further, products with the label 'no added sugar' had a higher % of processed plant source for pastes, extracts, and protein isolates ($r = 0.275$) and a higher number of minerals ($r = -0.269$).

Regarding the correlations between price information on the label and product prices, we found that milk alternatives with the label 'low price' were indeed associated with an overall lower price per litre ($r = -0.486$) compared to products without such labels (see Table 2). Moreover, some milk alternatives were associated with a higher product price per litre compared to the other products on the market for labels indicating 'climate footprint' ($r = 0.276$) and 'Nutri-Score' ($r = 0.255$). By contrast, products with the label 'low fat' were overall cheaper ($r = -0.339$).

## 4. Discussion

The aim of this study was, first, to investigate the number and types of labels present on the front-of-pack of plant-based milk alternatives from the Swiss market. Second, we aimed to better understand whether label information reflects product properties. Therefore, we investigated the congruence between the label information of a product and its nutritional and compositional value, as well as its price, using a Swiss database containing information on 66 products. Label information and product properties, such as nutritional values, compositional values, and price information, were retrieved from the packaging on the websites through a comprehensive market inventory on commercial milk alternatives.

### 4.1. *Number and types of labels*

Overall, our analysis identified a large heterogeneity in the types of labels of milk alternatives. Further, our results suggest that the types of labels were selected based on the plant source and the nutritional profile. We found that the 'vegan' label was the most frequently used label. The double or even triple presence of the 'vegan' label on a product contributed to this high number. The 'plant-based' label was also frequently used to promote the products as dairy-free. It is questionable whether these labels are useful or necessary, because previous research has shown that most consumers already know that milk alternatives are plant-based and dairy-free (Feltz & Feltz, 2019).

The discussion surrounding consumer perceptions and preferences regarding vegan and plant-based labels is controversial. One study showed that milk alternatives labelled with 'vegan' or 'plant-based' lead to less consumer choice compared to products where the label highlighted its benefits, such as 'healthy' or 'sustainable' (Sleboda et al., 2024). Another study, however, reported higher perceived benefits and preferences for the 'plant-based' label (focusing on plant-based ingredients), compared to the 'vegan' label (focusing on the absence of animal-based ingredients) (Lee et al., 2024). In contrast, other researchers found no significant differences in consumer preferences for milk alternatives labelled as 'vegan' or 'plant-based' (Branković et al., 2025). We suggest that the overall high number of labels on the front-of-pack of milk alternatives might further contribute to consumer's overload and can also be misleading (Koen et al., 2018), without showing necessarily beneficial effects for consumers.

Although it was shown that some milk alternatives have a lower environmental impact compared to milk (Herrmann et al., 2024; Poore & Nemecek, 2018), interestingly, we found that only a few products had an environmental sustainability label such as 'climate footprint'. One reason could be the limited understanding of the term 'sustainability' among consumers, as shown in a study of consumers from the UK, France, Germany, Spain, Sweden, and Poland (Grunert et al., 2014). However, self-explanatory labels such as the 'Carbon Footprint' or the 'Fairtrade' labels showed a better understanding among consumers (Grunert et al., 2014). This highlights the importance that label information is understandable to help consumers make an informed purchase decision.

Nowadays, many environmental labels for food products are already developed and in use, such as the Eco-Score (Stein & Lima, 2022), and previous research has shown that environmental labels with traffic lights on the front-of-pack can lead to more environmentally friendly food choices (Arrazat et al., 2023; Roesch et al., 2025).

Furthermore, a recent study found that consumers are willing to pay up to 27 % more for food products that display sustainability labels (Piracci et al., 2024). However, another study highlighted that environmental labels often lack a comprehensive assessment of the

environmental impact associated with food or drink production (Roesch et al., 2025). The underlying issues include poor methodology, weak scientific foundations, a lack of harmonization in emission models, insufficient transparency, and various commercial interests. To address these challenges, the researchers proposed using the Life Cycle Assessment (LCA) approach to calculate the environmental impact of food and beverage products for labelling purposes (Roesch et al., 2025).

In our study, no environmental traffic lights (such as the Eco-Score) were identified on the front-of-pack labels on milk alternatives in Switzerland. Nor could we find holistic and multi-faceted labels, such as the Mediterranean Index (Med Index), that combine nutritional, environmental, and social sustainability (Lisa Clodoveo et al., 2022; Zupo et al., 2023). Such labels prevent label overload (Futtrup et al., 2021) and would allow for easier comparison of products, which is necessary to guide consumers towards a more sustainable consumption.

Products such as milk alternatives, which are known to be more sustainable than milk from cows, can significantly contribute to the sustainable transformation of the food system. Skilful use of suitable environmental sustainability labels can facilitate nudging consumers towards a more sustainable product choice. We therefore perceive a lot of potential to increase the presence of sustainability labels in order to transform the food system towards a more resilient and sustainable environment. Applying a harmonized and coherent method, such as the Life Cycle Assessment (LCA) approach, appears to be highly relevant. To achieve this, more mandatory policies are needed to harmonise transparent food labelling that can promote healthy and sustainable product choices for high- and low-income consumers of milk alternatives (Koen et al., 2018). Moreover, enhancing consumer's understanding of front-of-pack label information to promote healthier and more sustainable food choices is thereby crucial (Koen et al., 2018).

### 4.2. Correlations between label information and product properties

Overall, we found that the information on the labels of milk alternatives reflected the nutritional values of the products and their prices. However, products with the label 'no added sugar' were not associated with reduced sugar content compared to products without such a label. Similar results were observed in another study, where milk alternatives labeled 'no added sugar' had the same sugar content as those without the 'no added sugar' label (Angelino et al., 2020). Interestingly, products with the 'no added sugar' label had a higher median carbohydrate content compared to those without such a label (Angelino et al., 2020). However, this result was not confirmed in our study. Although the label 'no added sugar' does not promote lower sugar content, it might confuse consumers and create the impression that such products have lower sugar content than others (as is, for example, the case for products with the label 'unsweetened'). Indeed, the results of a previous study showed that consumers struggled to understand the proper meanings of labels (Koen et al., 2018). This finding is of high relevance, as the label 'no added sugar' was among the most frequently identified labels. Similar findings in a Spanish study were recently confirmed elsewhere, where 50 % of all products ($n$ = 136) contained the label 'no added sugar' (Pérez-Rodríguez et al., 2023). As previously noted (Angelino et al., 2020, 2019; Pérez-Rodríguez et al., 2023), products with nutrition labels do not always exhibit superior nutritional quality compared to those without nutrition labels. Therefore, there is a need for more accurate nutrition labelling on milk alternatives to assist consumers in making informed dietary choices.

We found a Nutri-Score on front-of-pack labels only on 20 % of all products because it is not mandatory in Switzerland. This number is low, considering that the Nutri-Score is one of the most effective nutrition labels to inform consumers about the nutritional quality of foods (Egnell et al., 2020). Furthermore, a study demonstrated that the Nutri-Score can help nudge consumers towards healthier dietary choices (Robertson et al., 2023). Nevertheless, recent trends in Switzerland have shown that some industries no longer use the Nutri-Score label (Weder, 2024). The reasons given were higher prices, a reduced benefit for the company, and the potential to lead to consumer confusion (Weder, 2024). Another reason why the industry may no longer use the Nutri-Score label for plant-based milk alternatives is that the Nutri-Score for milk alternative has so far been mostly calculated using the food algorithm and not the beverage algorithm. Due to a recent update, the Nutri-Score for plant-based milk alternatives must be computed based on the beverage algorithm. Thus, stricter limits for sugar and additives will lead to lower Nutri-Score and nutritional quality, respectively.

Due to Nutri-Score labelling being voluntary in Switzerland, the label is only available for selected products, and, as in the case of milk alternatives, it is particularly available for products with a better nutritional profile. This reflects a lack of transparency by the food industry towards consumers. Similar findings of inconsistent labelling were reported elsewhere, where over 35 % of milk alternatives did not display the NOVA-Score (Rodríguez-Martín et al., 2023). In our study, no NOVA-Score was displayed on the front of the pack. We therefore recommend that nutritional information should be available, regardless of the nutritional quality of the products, to raise consumer awareness and contribute to an informed decision.

Further, we found that products with a 'Nutri-score' or a 'climate footprint' indication on front-of-pack labels had a higher price compared to products without such labels. These findings are in line with previous research, which found that sustainable foods are more expensive due to higher costs along the food supply chain for certifications (Grunert et al., 2014; Ling, 2013; Liu et al., 2019). Similar results were also observed by Pachali et al. (2023), where cereals with nutritional warnings tended to have higher prices compared to products without warnings. As a consequence of the increased price, it was further stated that consumers with a low income buy less often labelled products compared to high-income consumers. This might imply that consumers with a lower income might not have the same access to product information and instruments to make an informed purchase decision as high-income consumers. A recent study showed that households with a higher income reported better diet quality compared to low-income households (French et al., 2019). Thus, food labelling and its pricing system might also indirectly contribute to the inequality of healthy dietary choices between high- and low-income consumers.

### 4.3. Limitations and outlook

This study was conducted in the Swiss online market, which may limit the generalizability of the results. However, we believe that the results are transferable to other European countries, because 82 % of the products included in this study were produced outside Switzerland in other European countries. Therefore, this study includes data from different countries within European regions. Another limitation is that our database was from a market inventory of three online supermarkets, which are among the supermarkets with the largest offers in Switzerland. This might lead to the exclusion of small niche markets with potentially different label information. However, to obtain a holistic overview of the products, the three largest supermarkets provided the broadest market offerings.

More research is needed to investigate the labelling of new plant-based products, such as plant-based meat, yoghurt, and cheese. In addition, nutritional labels should be investigated for their accuracy between regulatory aspects (requirements for minimal and maximum nutritional values for a particular label claim, e.g. 'low fat') and nutritional values on the food packaging at the national level. Further, more consumer research is needed to investigate which labels (nutritional, environmental, etc.) and which format (maximal number of labels, etc.) are most useful to consumers. It might also be interesting to test consumers' expectations of the label 'no added sugar'. Labels are more likely to be useful nudges towards a more healthy and sustainable diet only if consumers are able to understand label information.

## 5. Conclusion

Overall, we found a large heterogeneity of label types among plant-based milk alternatives. In line with previous research, this study highlights the need for a simpler food labelling system for milk alternatives, which could be achieved through more binding food marketing regulations. The results of this study on milk alternatives suggest that the overall load of labels (including repetitive labels) should be reduced. In addition, potentially misleading labels (e.g. 'no added sugar' among products with sugar content similar to non-labelled products) should be avoided and more transparent nutrition information (poor and good nutritional quality) should be provided. Further, we perceive a great potential to increase the use of sustainability labels and multi-faceted labels on milk alternatives to help transform the food system towards a more resilient and sustainable environment. In addition to these leverages, educating consumers on how to use label information seems crucial. Stricter policy regulations targeting food marketing to enhance the consumer friendliness of labels for milk alternatives might facilitate sustainable behaviour change.

## Ethical statement

The authors declare that this manuscript does not involve any studies on humans or animals.

## CRediT authorship contribution statement

**Carole Liechti:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gabriele Mack:** Writing – review & editing, Visualization, Validation, Supervision, Conceptualization. **Jeanine Ammann:** Writing – review & editing, Visualization, Validation, Supervision, 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.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.afres.2025.100791.

## Data availability

Data will be made available on request.

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