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Research Article

A Systematic Scoring Framework for Evaluating and Comparing Foam Performance of Dairy and Plant-Based Barista Beverages

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Abstract: Dairy milk and plant-based milk alternatives exhibit unique foaming properties that are important for coffee applications. Therefore, evaluating foam performance is essential for understanding and optimizing the functionality and quality of these products. Over time, various methods and devices have been developed to measure individual foam attributes, including foamability, foam stability, liquid drainage, and bubble size. However, a widely accepted and standardized approach to comprehensively evaluate the overall foaming performance is not available. To address this gap, this study introduces a continuous scoring system designed to assess the overall foam performance by integrating fundamental foam properties critical for beverage applications. The applicability of this scoring system was demonstrated through evaluating the foaming properties of five commercially available barista beverages. The results revealed a strong correlation between the scoring system's output and visual observations of the foams, validating its practical relevance and accuracy. Its simplicity and effectiveness make this scoring system a valuable tool for quality control purposes in the dairy and plant-based beverage industries, and it could also provide a standardized approach for researchers and manufacturers, facilitating consistent product comparisons.

***Keywords*:** foams, foam properties, barista applications, foam evaluation

1. Introduction

During the last decades, the plant-based drinks industry, including barista beverages, has been rapidly expanding [1]. Dairy milk and plant-based drinks have distinct attributes, particularly regarding their foaming properties in coffee applications. Hereby, consumers increasingly tend to prefer plant-based drinks that offer sensory and foam qualities similar to dairy milk when added to their coffee [2]. Hence, having the ability to efficiently compare their foaming characteristics, including the foam attributes, has become very important [3-4].

Foams are dispersions of gas into a continuous liquid or solid phase produced after the application of external mechanical energy and are stabilised by surface-active molecules [5]. When it comes to dairy or plant-based drinks, a liquid foam is produced mainly through mechanical agitation or steam injection [6]. The amphiphilic nature of the proteins present in the drinks causes their adsorption at the gas-liquid interface, thereby decreasing the surface tension and allowing the gas cells to maintain their integrity and stability [7]. Proteins generally form stable, liquid-rich foams

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with thick adsorbed layers, but their slower adsorption rate compared to other surfactants results in lower foamability [8]. Proteins' foaming performance arises from the interplay of multiple interdependent physicochemical properties rather than a single dominant factor. Both intrinsic factors (e.g., amino acid composition, size, charge distribution) and extrinsic conditions (e.g., pH, ionic strength, temperature) can alter the functional properties of proteins [9]. Molecular flexibility and surface charge also play important roles by modifying the surface activity of the proteins, while surface hydrophobicity influences protein adsorption at the air/water interface, mainly impacting foam formation rather than foam stability [10-11].

While proteins are generally regarded as the principal contributors to foam formation and stability, the role of non-protein components in plant-based beverages is equally important and often more complex [12-14]. As highlighted in the literature, non-polar lipids, along with hydrophobic particles, can disrupt the air-water interface and promote antifoaming phenomena, thereby destabilizing foams [15-17]. Conversely, hydrocolloids (e.g., gums, pectins) influence the rheological properties of the bulk phase; by increasing viscosity, they can reduce drainage within the lamellae, leading to enhanced foam stability through an anti-drainage effect [18]. Carbohydrates, particularly sugars, may interact directly with proteins, altering their conformation or aggregation behaviour, which in turn can modulate foam formation and stability [19]. Given the complexity of plant-based beverage matrices, these interactions rarely occur individually, but instead, the combined effects of proteins and non-protein components create synergistic or antagonistic outcomes that determine the final foaming behaviour.

As foams are thermodynamically unstable systems that tend to destabilize (i.e., increase their bubble size) to reduce their interfacial energy, the foam quality decreases over time [20-21]. In the manufacturing process of barista beverages, either of dairy or plant-based nature, numerous factors have to be considered, such as the history of the raw materials, processing conditions, and molecular interactions, which can be responsible for the destabilization [22]. The main mechanisms driving foam destabilization and the subsequent decrease in foam quality include serum drainage, coalescence, and coarsening [23]. Serum drainage is the flow of liquid through the foam, driven by gravity and capillarity [24]. Coalescence involves the merging of gas bubbles, which includes the collision of bubbles, drainage of the liquid film during the collision, and eventual film rupture leading to the formation of larger bubbles [25]. Coarsening, which is also referred to as ripening, is caused by the diffusion of gas molecules from smaller bubbles to larger ones due to Laplace pressure differences [24, 26-27].

These phenomena occur simultaneously and influence each other, making it challenging to describe and control the underlying mechanisms [12]. Coarsening and especially coalescence are linked to gravity drainage and accelerate when the foam's liquid content is reduced [28]. The liquid goes downward in motion, while the air bubbles move upwards, as a result of density differences and gravitational forces causing the bubbles to come into proximity to neighbouring bubbles. This creates a drier foam structure at the top (leading to polyhedral shapes), which is visible to the consumer in a coffee cup, and a wetter foam structure at the bottom, characterised by a more spherical bubble shape [29].

Literature regarding foams and their characteristics primarily focuses on foamability and foam stability, based on the foam volume only, thereby often overlooking the "quality" of the foam itself. Foamability refers to the ability of a solution to produce foam, measured as the increase in volume upon foaming in absolute or relative terms [30]. On the other hand, foam stability examines how well a foam maintains its volume over time, whereby the stability of the foam until the moment of consumption (typically up to 10-15 min after foam generation) is a key requirement in cappuccino-style beverages [31]. However, a stable foam does not necessarily indicate a high-quality foam, as a stable foam volume can be obtained with either large bubbles with only a limited amount of entrapped liquid (common in dry foams), or small bubbles retaining a significant amount of liquid. Thus, foam characteristics should be more accurately divided into foam quantity (which may also be referred to as foamability) and foam quality (which is linked to foam stability and bubble size).

Based on this information, the liquid content in foams is closely tied to their visual appearance. Thus, bath-type foams, with large bubbles separated by thin liquid films, have a very low liquid content, whereas microfoams, made up of smaller bubbles with thicker liquid films, contain a much higher liquid fraction. Therefore, determining the liquid content within the foam structure, along with evaluating its foam capacity and stability, seems crucial, as it indirectly reflects the bubble size.

Although the physicochemical properties of food foams are relatively well understood, the dynamics of bubbles within food systems remain less thoroughly characterized [32]. Before taking that step of understanding, it is necessary to have a simple evaluation tool that allows the reliable comparison of different foams, considering their overall foam performance. While some specific devices are commercially available that allow the determination of various foam characteristics, no specific method enables foam evaluation by combining different properties into a unique foam quality indicator. Hence, the aim of this work was the development of a foam properties "toolbox" for the quantitative evaluation of the overall foaming properties of different milk and plant-based drinks, which could be easily applied in both research and quality control. By providing objective measurements of foam characteristics, this analytical toolbox enables manufacturers to systematically optimize formulations, refine ingredient selection, and adjust processing conditions. In addition, it facilitates benchmarking against dairy-based foams and supports the development of evidence-based marketing claims, thereby contributing to improved consumer acceptance and strengthened competitive positioning within the expanding plant-based beverage market.

2. Materials and methods

2.1 *Materials*

A commercial milk frother (Nespresso Aeroccino 3, Nespresso S.A., Lausanne, Switzerland) was used to froth different dairy and plant-based drinks, typically used for barista applications at home. A barista full-fat cow's milk (Barista Milch) obtained from Weihenstephan (Germany) served as the reference sample for the determination of its foaming properties, while four commercially available plant-based barista drinks with different nutritional profiles (Table 1) obtained from Alpro (Wevelgem, Belgium) were also tested.

Table 1. Nutritional composition (in % w/v) of barista cow's milk, barista soy drink, barista oat drink, barista almond drink, and barista coconut drink

	Barista cow's milk	Barista soy drink	Barista oat drink	Barista almond drink	Barista coconut drink
Protein	4.0	3.3	0.8	0.5	1.5
Carbohydrates	4.9	2.7	6.7	2.5	3.3
Fat	3.0	1.9	3.0	1.2	1.4
Fiber	0.0	0.6	1.0	0.2	0.2
Salt	0.12	0.10	0.13	0.08	0.10

2.2 *Foam properties determination*

A standard amount of sample (100 ml) at 6 °C was added to the aeration device, where it was whipped while heating, until the temperature of the sample reached approximately 60 °C. Directly after the foam generation procedure, the serum and the foam were transferred to a 250 ml glass measuring cylinder, and their volumes were recorded. Based on the obtained data and by utilising the equations proposed by Silva et al. [6] with minor changes, the following characteristics were determined (Equations (1)-(5)):

$$\text{Total Volume } \left(TV_{x\text{ min}}\right) = V\text{ foam}_{(x\text{ min})} + V\text{ serum}_{(x\text{ min})} \qquad (\text{ml}) \tag{1}$$

$$\text{Foam Capacity } \left(FC_{x\text{ min}}\right) = \frac{V\text{ foam}_{(x\text{ min})}}{V\text{ drink}} \times 100 \qquad (\%\text{ v/v}) \tag{2}$$

$$\text{Relative Foam Capacity Decay } \left(RFCD_{0-10\text{ min}}\right) = \frac{FC_{0\text{ min}} - FC_{10\text{ min}}}{FC_{0\text{ min}}} \times 100 \qquad (\%\text{ v/v}) \tag{3}$$

$$\text{Foam Liquid Fraction } \left(FLF_{x\text{ min}}\right) = \frac{V\text{ drink} - V\text{ serum }_{(x\text{ min})}}{V\text{ drink}} \times 100 \qquad (\%\text{ v/v}) \tag{4}$$

$$\text{Relative Foam Liquid fraction Decay } \left(RFLD_{0-10\text{ min}}\right) = \frac{FLF_{0\text{ min}} - FLF_{10\text{ min}}}{FLF_{0\text{ min}}} \times 100 \qquad (\%\text{ v/v}) \tag{5}$$

The total volume, foam capacity, and foam liquid fraction indicate the actual situation at one specific moment, which is either directly after foam generation or 10 minutes later. The latter was chosen, as consumers typically begin consuming their coffee shortly after preparation; thus, assessing foam properties within a 10-minute window provides a realistic representation of consumption conditions. As all experiments were done starting with 100 ml of drink (a sufficient amount to fill the cup post aeration, without wasting a lot of the product), it follows that the foam capacity indicates both the overrun (expressed in % v/v) and the absolute amount of foam (expressed in ml). Similarly, the foam liquid fraction indicates what fraction of the original liquid is included in the foam layer x minutes after foam generation (in % v/v), as well as the actual volume of the liquid hold-up in the foam structure (expressed in ml). As far as the relative foam capacity decay and relative foam liquid fraction decay are concerned, they express the evolution during the first 10 minutes after foam generation: whereas the former indicates what fraction of the original foam volume got lost, the latter expresses what percentage of the original liquid content in the foam disappeared upon storage (due to drainage).

2.3 *Statistical analysis*

Statistical analysis was performed using the statistical software SPSS (version 29.0.1.0, IBM Corp). One-way Analysis of Variance (ANOVA) and Tukey's Studentized Range Post-hoc test for equal variances and the Games-Howell test for unequal variances, with a 95% level of significance ($p < 0.05$), were utilised to compare group differences between the examined foaming characteristics.

3. Results and discussion

3.1 *Foam characterisation based on classical characteristics*

To evaluate foam quality differences across products with varying foaming performance, five commercially available barista-style drinks, each characterized by a distinct foam profile, were analysed for various foam characteristics. Based on the results, important factors influencing the foam quality were identified, and an attempt was made to classify the drinks accordingly.

A standard cappuccino cup has a capacity of 180 ml, with an added espresso shot contributing 25-30 ml [33]. Consequently, a minimum of 150-155 ml of frothed drink is required to fully fill the cup and achieve an adequate foam volume for a standard cappuccino, highlighting the importance of total volume directly post aeration ($TV_{0\text{ min}}$) in foam profiling. As represented in Figure 1a, all the tested samples except the almond drink fulfilled this criterion, having a total volume of at least 210 ml. The total volume of the drink 10 minutes post-aeration ($TV_{10\text{ min}}$) was also measured, and a similar trend was observed upon comparing the different drinks. By taking into consideration that foam destabilization and liquid drainage take place over time, $TV_{10\text{ min}}$ was not considered a foam quality characteristic for foam classification, as it does not distinguish between the foam and serum components within the total volume, and can be a misleading indicator.

Further than just filling a cappuccino cup with milk or a plant-based beverage, the amount of produced foam is also important, as a sufficient amount of foam enables latte art formation. Hence, the foam capacity of the drinks was also investigated. Based on the obtained results, the barista almond drink exhibited the lowest foaming capacity directly post-aeration and 10 min later, producing significantly less foam than the other samples (Figure 1b). Conversely, the barista soy drink exhibited the highest capacity, whereas the remaining beverages demonstrated similar foam capacity values, generating approximately 200 ml of foam after aeroccino processing. Similar results were reported by Sze-Tao et al. [34], who found that almond protein isolates exhibited a lower foaming performance than soy isolates at the same protein concentration, underscoring intrinsic functional differences between the two proteins. Beyond these compositional properties, the substantial gap in protein concentration between the almond (0.5%) and soy (3.3%) drinks likely amplified the observed contrast in foam formation. Evidence from potato protein isolates further supports this interpretation, showing that the foamability becomes largely independent of protein content once a certain threshold is reached, whereas the foaming capacity decreases sharply when the protein level falls below approximately 1% [35].

Foam stability was also investigated by using two parameters, i.e., the foaming capacity 10 min post aeration ($FC_{10\ \mathrm{min}}$) and the relative foam capacity decay during the first 10 min ($RFCD_{0\text{-}10\ \mathrm{min}}$). While all samples exhibited a comparable relative decrease in foam volume, as reflected by similar $RFCD_{0\text{-}10\ \mathrm{min}}$ values, only cow's milk and the oat-based drink showed statistically significant differences. In contrast, the absolute residual foam volume measured 10 minutes post-aeration varied more substantially among samples. Given that in practical coffee applications, the key quality attribute is the ability to maintain sufficient foam volume consisting of small bubbles throughout consumption, rather than simply minimizing the rate of foam loss, $FC_{10\ \mathrm{min}}$ appears to be a more meaningful and functionally relevant characteristic of foam stability. This is particularly important when initial foam volumes may already be suboptimal, rendering a low rate of decay less informative from a performance perspective.

Zakidou et al. [2] studied the foam properties of various plant-based drinks and cow's milk when aerated by stirring or steaming. They found that, regardless of the aeration method, cow's milk had the highest foam expansion and stability, attributed to its high protein content and potential casein-whey protein interactions at the air-water interface. In contrast, plant-based drinks showed a significantly lower stability and expansion, likely due to their lower protein content and generally weaker functional properties. However, our findings do not support that hypothesis, as the oat drink exhibited a foam capacity comparable to soy and coconut drinks, as well as cow's milk, despite containing four times less protein. This supports the idea that foamability is a multifactorial characteristic influenced by the physicochemical properties of proteins, such as solubility, flexibility, and hydrophobicity, as well as their interactions with other components and factors, like pH and ionic strength [9, 30, 36].

Beyond foam volume, the foam structure also plays a crucial role in the sensory experience for consumers. As observed in Figure 2, although the oat drink exhibited a high foam capacity 10 minutes post-aeration, its foam structure appeared to be drier compared to the rest of the samples, indicating the influence of another key factor, which affects the retention of a dense microfoam, known as foam liquid fraction. Therefore, this specific characteristic was determined 10 min post aeration for all the examined samples, and the results indicated that the oat drink had the lowest foam liquid fraction 10 min post aeration ($FLF_{10\ \mathrm{min}}$), contributing to its poor foam quality (Figure 1c). By taking into consideration that liquid drainage from the foam matrix typically becomes pronounced only several minutes after aeration, the foam liquid fraction measured immediately post-aeration ($FLF_{0\ min}$) does not reliably reflect long-term foam quality. As such, it was not found to be a dependable indicator of overall foam performance. Furthermore, the relative foam liquid fraction decay ($RFLFD_{0\text{-}10\ \mathrm{min}}$) was also determined to assess its relevance in foam quality evaluation. The maximum foam liquid fraction retention after 10 min ($FLF_{10\ \mathrm{min}}$) was approximately 30% (v/v), whereby a small difference of 7% (v/v) could significantly impact the visual appearance and perceived quality of the foam, as confirmed by the visually observed differences between cow's milk ($FLF_{10\ \mathrm{min}}$ = 10.7%) and the oat drink ($FLF_{10\ \mathrm{min}}$ = 4.0%). Since the $RFLFD_{0\text{-}10\ \mathrm{min}}$ only reflects the rate of decline over time, it fails to capture absolute differences, making it less effective for distinguishing variations in foam quality. Hence, it was also not considered as a classification characteristic.

As described previously, multiple characteristics can be utilised when it comes to foam quality characterisation. Hereby, $TV_{10\ \mathrm{min}}$, $FC_{0\ \mathrm{min}}$, $FC_{10\ \mathrm{min}}$, and $FLF_{10\ \mathrm{min}}$ were identified as the primary characteristics significantly contributing to the overall foam performance in barista-style beverages. However, relying solely on these characteristics to describe the foaming behaviour can be misleading, as different drinks excel in different aspects. When the $FC_{0\ \mathrm{min}}$ and $FC_{10\ \mathrm{min}}$ were evaluated independently, the almond drink emerged as the lowest performer, whereas the soy drink demonstrated the highest performance (Figure 1b). On the other hand, assessing the foam quality based solely on the $FLF_{10\ \mathrm{min}}$ presented a different outcome, whereby the oat drink was characterised by the lowest value among the different samples (because of its high liquid drainage), while the coconut drink revealed the highest values. As a result, assessing the overall foam characteristics is a complex task, making it challenging to accurately classify and compare beverages of different origins. Consequently, the need for a standardized, comprehensive scoring system that effectively quantifies the interplay among various foam properties was showcased.

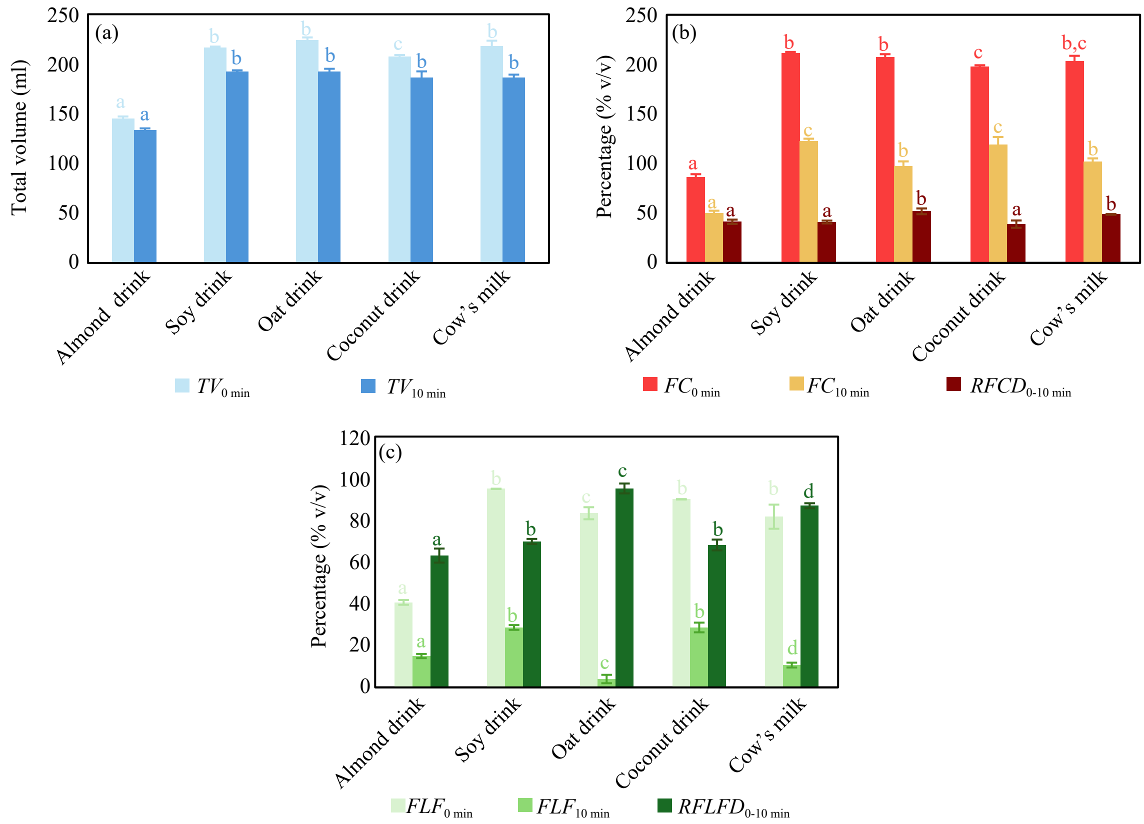

Figure 1. (a) Total Volume (*TV*) of barista soy, oat, almond, coconut drink, and cow's milk directly and 10 min post aeration. (b) Foam Capacity (*FC*) and Relative Foam Capacity Decay (*RFCD*) of barista soy, oat, almond, coconut drink, and cow's milk directly and 10 min post aeration. (c) Foam Liquid Fraction (*FLF*) and Relative Foam Liquid Fraction Decay ($RFLFD_{0\text{-}10\ min}$) of barista soy, oat, almond, coconut drink, and cow's milk directly and 10 min post aeration. Different letters above bars of the same colour denote significant differences among the examined products for the corresponding characteristic ($P < 0.05$, $n = 3$)

Figure 2. Foam images of barista oat, almond, soy, and coconut drink, and cow's milk taken 10 min post aeration, arranged from left to right, showcasing a gradual visual improvement in quality

3.2 *Foam properties scoring system development and application*

A scoring system that enables the quantitative assessment of foam was developed. A continuous approach was chosen for scoring, whereby indices were introduced based on the total volume, foam capacity, foam stability, and foam liquid fraction (Eq. (6)-(9)). Each index was designed to have a 0-10 scale to ensure that each characteristic contributed equally to the final evaluation. Therefore, rescaling parameters were used in these equations, based on the optimal foaming performance of commercially available examined drinks, i.e. a $TV_{0\ min}$ of 240 ml, $FC_{0\ min}$ of 240% v/v, $FC_{10\ min}$ of 130% v/v, and $FLF_{10\ min}$ of 30 ml (upon foaming of 100 ml of drink), leading to a score of 10 for each index. To ensure optimal foam volume in a standard cappuccino preparation, a minimum *TVI* value of 6.5 was determined. Given a standard serving size of 180 ml and an espresso base volume of 25 ml, this *TVI* corresponds to a final aerated product volume of approximately 156 ml, ensuring adequate milk froth expansion. Averaging these indices provided a more comprehensive and effective evaluation of the foaming properties across beverages. Hereby, two averages were calculated, as shown in Eq. (10) and (11), which are based on the combined characteristics directly after preparation as well as after 10 min (for Eq. (10)), or only on the characteristics 10 minutes after aeration (for Eq. (11)), allowing straightforward foam comparison:

$$\text{Total Volume Index } (TVI) = \frac{TV_{0\,\text{min}}}{24} \tag{6}$$

$$\text{Foam Capacity Index } (FCI) = \frac{FC_{0\,\text{min}}}{24} \tag{7}$$

$$\text{Foam Stability Index } (FSI) = \frac{FC_{10\,\text{min}}}{13} \tag{8}$$

$$\text{Foam Liquid Fraction Index } (FLFI) = \frac{FLF_{10\,\text{min}}}{3} \tag{9}$$

$$\text{Overall Foam Performance } \left(OFP_{0-10\,\text{min}}\right) = \frac{TVI + FCI + FSI + FLFI}{4} \tag{10}$$

$$\text{Foam Quality after } 10\,\text{min} \left(FQ_{10\,\text{min}}\right) = \frac{FSI + FLFI}{2} \tag{11}$$

The overall foam performance ($OFP_{0\text{-}10\text{ min}}$) and foam quality ($FQ_{10\text{ min}}$) after 10 min were compared with visual observations of the aerated foams (Figure 2). Based on these indices, the barista soy drink emerged as the top performer, characterized by a substantial total volume and foam production, excellent foam stability, and minimal serum drainage from the foam ($OFP_{0\text{-}10\text{ min}} = 9.0$, $FQ_{10\text{ min}} = 9.6$) (Figure 3). The barista coconut drink followed closely, displaying a high foam quality after 10 min with a well-retained foam liquid fraction, but with slightly lower, though not significantly, foam capacity ($OFP_{0\text{-}10\text{ min}} = 9.0$, $FQ_{10\text{ min}} = 9.4$). These quantitative findings align with the visual observations in Figure 2, where both the soy and coconut drinks exhibited a superior foam quality, marked by a stable microfoam with small, wet bubbles.

For cow's milk, the foam averages were significantly lower as compared to the soy and coconut drinks ($OFP_{0\text{-}10\text{ min}} = 7.4$, $FQ_{10\text{ min}} = 5.8$), primarily due to a suboptimal foam liquid fraction retention expressed through the foam liquid fraction index ($FLFI = 3.4$) (Figure 4). This resulted in a visually drier foam structure 10 minutes after aeration, although the bubble size remained small. In contrast, the barista almond drink, though showing a relatively high foam liquid fraction retention, struggled with an exceptionally low foamability, leading to a low overall foam performance ($OFP_{0\text{-}10\text{ min}} = 4.7$). On the other hand, the barista oat drink, while not exhibiting the lowest overall foam performance, was characterised by the poorest foam quality after 10 min due to notable serum drainage, despite a reasonable foamability and foam stability ($OFP_{0\text{-}10\text{ min}} = 6.8$, $FQ_{10\text{ min}} = 4.5$). According to previous studies, water-soluble oat proteins (albumins) and 12S globulins contribute to foam formation and stability through distinct mechanisms: the former rapidly diffuse to the air-water interface, forming viscoelastic interfacial films, while the latter undergo structural rearrangements upon adsorption, enhancing thin liquid film stability [37]. The high serum drainage observed 10 minutes post-aeration induces thin liquid film rupture, indicating insufficient interfacial stabilization [12]. This destabilization could result from reduced protein functionality due to aggregation caused by severe heat treatment during processing, or from the presence of non-polar lipids, which have been reported to destabilize interfacial films [7, 16, 17, 38-39]. More investigation seems to be necessary to identify the underlying mechanism behind the low foam quality of the barista oat drink.

Based on the findings for the different drinks, the value of the combined indices in assessing and comparing the foaming characteristics is underlined, offering a consistent and practical method for quantitative and objective evaluation. It's noteworthy that although the applied indices provide a practical and objective measure of foam characteristics, they do not encompass all relevant aspects of foam quality. Parameters such as bubble size distribution and foam viscosity, which are known to influence sensory perception, were not considered in the present study due to the requirement for more advanced analytical instrumentation. Nevertheless, the scoring system was found to effectively capture the visually observed differences between the various foams, thus validating it as a reliable tool for measuring and characterizing the foaming properties across different beverages.

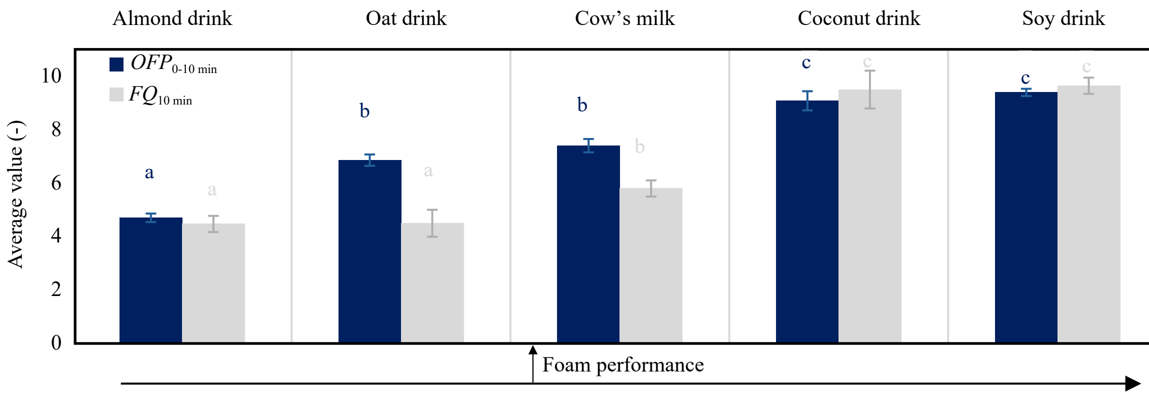

Figure 3. Overall foam performance ($OFP_{0\text{-}10\ min}$; average of total volume, foam capacity, foam stability, and foam liquid fraction index) and foam quality after 10 min ($FQ_{10\ min}$; average of foam stability and foam liquid fraction index) of barista soy, oat, almond, coconut drink, and cow's milk. Different letters above bars of the same colour denote significant differences among the examined products for the corresponding characteristic ($P < 0.05$, $n = 3$)

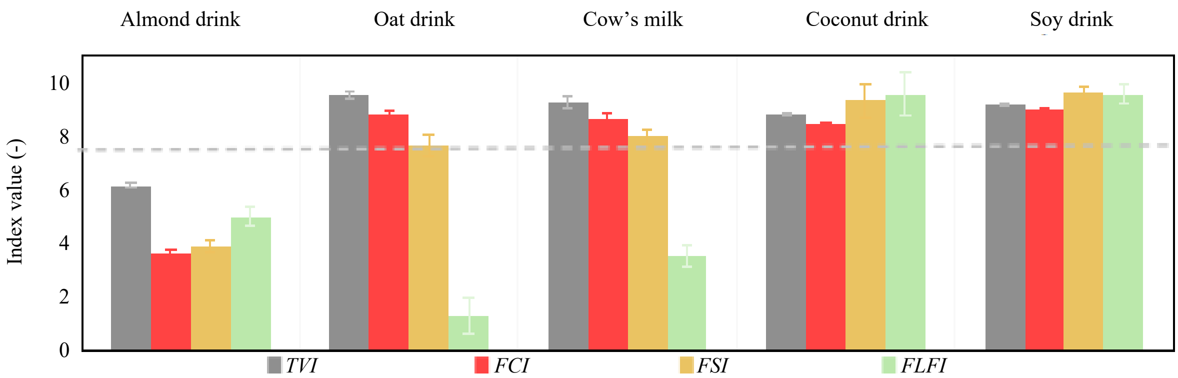

Figure 4. Total Volume Index (*TVI*), Foam Capacity Index (*FCI*), Foam Stability Index (*FSI*), and Foam Liquid Fraction Index (*FLFI*) of barista soy, oat, almond, coconut drink, and cow's milk. The dashed line indicates the minimum Total Volume Index benchmark

4. Conclusions

In this study, a continuous scoring system was introduced to evaluate the foaming characteristics of dairy drinks and plant-based milk alternatives for barista applications, addressing the gap between qualitative visual assessments and quantitative scientific characterization. The developed foam properties "toolbox" enables straightforward comparison of overall foam performance and quality through two metrics by combining different foam parameters. Due to its simplicity and practicality, the scoring system could be a promising approach for industrial applications, such as evaluating the foaming performance of barista beverages during quality control processes, while it could also serve as a complementary tool to existing foam analyzers by incorporating the developed indices to enhance their effectiveness across the market.

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Conflict of interest

The authors declare no competing financial interest.

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