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SENSORY QUALITY OF COMMERCIAL OAT – BASED MILK ALTERNATIVES AVAILABLE IN NORTH MACEDONIA

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Abstract: This study aimed to evaluate the sensory profile of commercially available oat-based milk alternatives in North Macedonia. The sensory acceptability is influenced by key attributes such as taste, texture, odor, and appearance. In this study, sensory analysis revealed significant differences ($p<0.05$) among the evaluated samples, particularly in texture, taste, aftertaste, and overall acceptance. Sample 6 received the highest overall acceptability score (7.5), outperforming other samples in taste, aftertaste, and texture. Panelists' responses indicate that taste plays a pivotal role in consumer acceptance. These findings highlight the importance of optimizing sensory attributes to improve consumer acceptance and broaden the market appeal of oat-based milk alternatives.

Keywords: oat, milk alternatives, sensory analysis, consumer preference

Introduction

Oats (*Avena sativa*) belong to the *Poaceae* family, one of the largest plant families that include other essential cereal crops such as wheat, barley, and rice. Primarily cultivated in temperate regions, oats are highly valued for their rich nutritional profile, which includes high-quality proteins, dietary fiber, lipids—particularly unsaturated fatty acids—vitamins, antioxidants, phenolic compounds, and essential minerals (Ahmad et al., 2014). Among their notable bioactive compounds, β-glucans, avenanthramides, and avenacosides have been linked to various health benefits, including cholesterol reduction, improved gut health, and anti-inflammatory properties (McCarron et al., 2024). Oat-based milk alternatives have gained significant popularity due to their low allergenicity, appealing sensory characteristics compared to other plant-based milk alternatives, and their potential health-promoting effects. The growing consumer preference for these products is driven by multiple factors, including

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increasing awareness of lactose intolerance and milk allergies, rising health consciousness, and the shift toward plant-based diets. Additionally, concerns about the environmental impact of dairy production, ethical considerations regarding animal welfare, evolving lifestyle choices, and the influence of targeted marketing campaigns have contributed to the expanding demand for milk alternatives (Crittenden, 2007).

The production of oat-based milk typically involves several key steps, including cleaning, enzymatic hydrolysis, filtration, and homogenization, to achieve a desirable texture and flavor (Zhou et al., 2023). However, variations in processing methods among different producers can lead to differences in the physicochemical and sensory properties of the final product, as well as potential nutrient losses, including vitamins and minerals (Klose and Arendt, 2012). Furthermore, processing conditions can alter the structural characteristics of β-glucans, potentially affecting their functional properties, such as solubility and viscosity, which play a crucial role in the texture and stability of oat milk (Henrion et al., 2019).

As consumer interest in plant-based dairy alternatives continues to grow, the global market for milk alternatives has expanded significantly. In 2023, the market was valued at approximately USD 9,310.6 million, and due to increasing demand in downstream sectors, it is projected to reach USD 15,730 million by 2030, with a compound annual growth rate (CAGR) of 7.8% during the forecast period (Market Research, 2024). This rapid growth underscores the rising adoption of plant-based dairy alternatives and highlights the need for continued innovation in oat milk production to enhance its nutritional quality, sensory attributes, and overall market appeal.

Materials and methods

Six samples of oat milk, purchased from the retail market in 1 L Tetra Pak packaging, were analyzed. The sensory evaluation of the oat based milk alternatives was conducted with 32 semi-trained assessors using a 9-point hedonic scale, ranging from 1 (extremely dislike) to 9 (extremely like). Each assessor received approximately 20 mL of oat milk alternative, served in a glass cup labeled with a randomized three-digit code. The samples were presented at room temperature. The assessors evaluated key attributes, including appearance (consistency and color), odor, texture (mouthfeel), taste, aftertaste, and overall acceptance. Additionally, they were asked whether they would purchase each product or not.

Statistical analysis

Statistical analysis was performed using 2-way analysis of variance (ANOVA) followed by Fisher's Least Significant Difference (LSD) test. The statistical analysis was performed using XLSTAT software version 2019.2.2 (Addinsoft, New York City, New York, USA). The level of significance was set at $p < 0.05$.

Results and discussion

Sensory acceptability of a product is influenced by various factors, including its overall quality, consumer familiarity, and individual consumption preferences. Key attributes such as taste, texture, aroma, and appearance play a crucial role in determining consumer satisfaction. Additionally, external factors such as cultural influences, prior experiences, marketing strategies, and product presentation can significantly impact how a product is perceived and accepted by consumers. Based on the sensory analysis results presented in Table 1, significant differences ($p<0.05$) were observed among the evaluated oat based milk alternatives in terms of texture, taste, aftertaste and overall acceptance. Sample 5 received the highest rating for appearance (6.97), which panelists attributed to its color being the most similar to conventional cow's milk. However, despite its appealing visual attributes, Sample 5 received the lowest score for taste (5.97). Several panelists specifically noted that this sample had the most pronounced bitter taste among all tested oat milk alternatives, which negatively impacted its overall sensory acceptability. In contrast, Sample 6 emerged as the most favorably rated product, receiving the highest scores across multiple sensory attributes, including odor, texture, taste, and aftertaste. With an overall acceptability score of 7.5, Sample 6 was described by panelists as the best-tasting oat milk among those tested. Some panelists further emphasized that its taste and aftertaste were superior compared to the other samples, making it a preferred choice. Similarly, Sample 3 also demonstrated favorable sensory characteristics, ranking as the second-best-rated product. Panelists described its taste as notably sweet and pleasant, contributing to its higher acceptability. Conversely, Sample 4 received the lowest scores for analyzed parameters. Furthermore, noticeable differences in appearance were observed, likely due to its watery and diluted texture with minimal fat droplets.

Table 1. Sensory evaluation of oat milk alternatives

Sample	Appearance (consistency and color)	Odor	Texture (mouthfeel)	Taste	After taste	Overall acceptance
Sample 1	6.66±1.81^{a}	5.69±2.20^{a}	6.22±2.15^{b}	6.41±2.33^{ab}	6.34±2.22^{bc}	6.75±1.80^{ab}
Sample 2	6.66±1.95^{a}	6.28±2.58^{a}	6.66±2.20^{ab}	6.22±2.10^{b}	6.03±1.96^{bc}	6.44±1.90^{b}
Sample 3	6.69±2.19^{a}	5.99±2.83^{a}	7.06±2.06^{ab}	6.84±2.20^{ab}	6.84±2.24^{ab}	7.00±1.85^{ab}
Sample 4	6.25±2.06^{a}	5.63±2.34^{a}	6.16±1.95^{b}	5.97±2.13^{b}	5.84±1.75^{c}	6.28±1.84^{b}
Sample 5	6.97±1.96^{a}	6.00±2.28^{a}	6.13±2.33^{b}	5.97±2.11^{b}	5.91±2.07^{bc}	6.59±1.75^{b}
Sample 6	6.75±2.12^{a}	6.59±2.30^{a}	7.66±1.55^{a}	7.44±1.75^{a}	7.50±1.62^{a}	7.59±1.56^{a}

*Different small letters in superscript in the same column indicate statistically significant differences ($p<0.05$)

Taste plays a pivotal role in consumer preferences for plant-based milk alternatives and is considered a key determinant in purchasing decisions (Adamczyk et al., 2022). Research suggests that taste is the primary driver influencing the consumption of plant-based milk, as consumers seek products that closely resemble the flavor profile of traditional dairy milk (Collier et al., 2023). The phenolic compounds present in oats, particularly avenanthramides, can influence the sensory properties of oat-based products. These bioactive compounds have been associated with bitter and astringent sensations, which may impact overall taste perception and consumer acceptability (Günther-Jordanland, et al., 2016). Preferences for oat-based milk alternatives vary, with some consumers favoring the natural flavors of oats, while others prefer formulations with added sweetness to enhance palatability. Furthermore, Gorman et al. (2021) found that consumers particularly favored plant-based milk alternatives that contributed a sweet taste. Additionally, Amyoony et al. (2023) observed that first-time consumers of plant-based milk alternatives often expressed dissatisfaction with the aftertaste, particularly when it differed significantly from that of conventional dairy products. Their findings highlight that individuals new to plant-based dairy substitutes tend to prefer products with a more familiar aftertaste, resembling traditional animal-based dairy.

As illustrated in Table 1, Sample 6 consistently achieved the highest scores across all assessed parameters, resulting in the highest overall acceptability. Additionally, as shown in Figure 1, none of the panelists rated this sample negatively in terms of acceptability. These findings indicate that various factors influence the quality of oat milk, including the type of raw materials used, production technology, added ingredients, storage conditions, and shelf life (Trajkovska et al., 2024). According to Zhou et al. (2023), the overall acceptability of oat based milk products is primarily driven by taste and

appearance, as these are key sensory attributes influencing consumer preferences. Overall, these findings underscore the importance of optimizing the sensory attributes of oat milk alternatives to align with consumer preferences, particularly in terms of taste and aftertaste. Addressing bitterness and enhancing the sweetness profile may improve consumer acceptance and broaden the market appeal of oat-based milk alternatives.

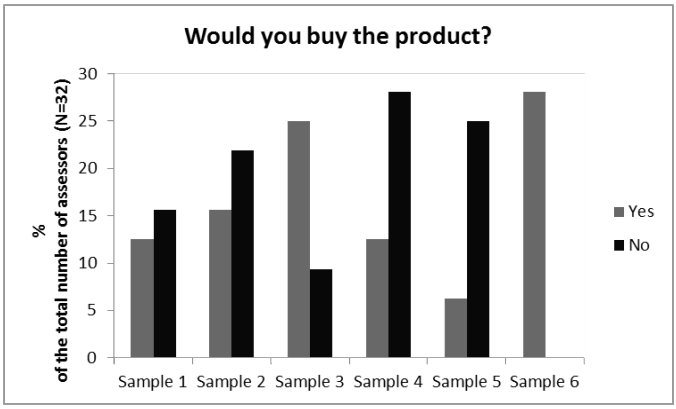

Figure 1. Consumer purchase intent for oat milk alternative samples based on sensory evaluation

Conclusion

The results of this study confirm that sensory attributes, particularly taste and aftertaste, play a crucial role in consumer preferences for oat-based milk alternatives. Sample 6 emerged as the most preferred formulation, achieving the highest scores across all sensory parameters, while Sample 5, despite its appealing appearance, was rated lowest in taste due to bitterness. Phenolic compounds, such as avenanthramides, contribute to sensory perceptions, potentially influencing consumer acceptability. Enhancing sweetness and reducing bitterness could improve overall acceptability and expand market opportunities for oat-based milk alternatives. These findings emphasize the importance of raw material selection, production techniques, and ingredient optimization in ensuring high-quality oat milk products that meet consumer expectations.

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