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Sentiments and flavors: An approach to gastronomic innovation in the Algarve

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Abstract

PURPOSE: *This study explores how the Mediterranean Diet, recognized by UNESCO as Intangible Cultural Heritage, can be leveraged innovatively to enhance the sustainability of the Algarve as a tourism destination. The objective is to identify and valorize local resources aligned with the Mediterranean dietary pattern to create new gastronomic experiences that appeal to tourists and support regional development.* ***METHODOLOGY:*** *A mixed-methods approach was adopted. Sentiment analysis was conducted on enogastronomic experiences shared on social media to understand tourists' perceptions and preferences. This was complemented by a Delphi-based focus group with regional experts to co-create and evaluate innovative culinary proposals. Finally, a gastronomic experience was implemented in a local restaurant to test the developed products.* ***FINDINGS:*** *The sentiment analysis revealed key emotional and experiential factors that shape tourist satisfaction. Based on these insights, five innovative appetizers were developed and tested, demonstrating above-average levels of appreciation and potential for economic valorization.* ***IMPLICATIONS:*** *The study contributes to the theoretical understanding of how intangible cultural heritage can be operationalized in tourism innovation. Practically, it offers an exploratory framework for integrating local gastronomy into sustainable tourism strategies, which requires further validation in larger-scale settings.* ***ORIGINALITY AND VALUE:*** *This research uniquely combines digital sentiment analysis with participatory culinary innovation, offering a novel interdisciplinary approach to enhancing gastronomic tourism through the Mediterranean Diet. The findings should be interpreted as exploratory and hypothesis-generating rather than definitive.*

***Keywords*:** *Mediterranean Diet, sentiment analysis, sustainable tourism destination, innovative experiences, gastronomic tourism; culinary innovation; intangible cultural heritage, sentiment analysis, sustainable tourism, Algarve, tourist experience, local food systems, destination development*

INTRODUCTION

The Mediterranean Diet (MD), recognized by UNESCO as Intangible Cultural Heritage, is fundamental to safeguarding cultural identity and fostering sustainable tourism development (Stalmirska & Ali, 2023). However, to develop sustainable tourism products that integrate both production and consumption dimensions, innovation within the MD must be grounded in contemporary consumer values and expectations (Mehraliyev et al., 2022).

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Analyzing tourists' experiences through sentiment analysis of social media content offers an effective approach to understanding these preferences, informing the creation of innovative products and services that address regional sustainability concerns (FAO, 2022; Mehraliyev et al., 2022). While the cultural and health benefits of the MD have been extensively documented, prior research has largely focused on its gastronomic and cultural dimensions (Sánchez-Hernández, 2023; Graça, 2014), overlooking how consumer insights can guide innovation–a gap this study addresses. Another significant gap remains in the literature regarding the application of sentiment analysis to understand tourists' experiences with MD-related offerings. This represents a missed opportunity to enhance tourist satisfaction and promote sustainable tourism in the Mediterranean.

This study addresses the research question: How can consumer insights derived from sentiment analysis guide the innovation of appetizers based on the MD to enhance the gastronomic tourism offer in Tavira, Algarve? It also aims to explore how such innovation might support the transition to sustainable food systems and align with the Sustainable Development Goals (SDGs), without directly measuring those outcomes. By developing and testing new products and experiences based on MD staples, the research seeks to diversify the Algarve's tourism offer, enrich enogastronomic experiences, and reinforce regional authenticity. Additionally, it aims to create value for local communities by developing new products and services.

The paper is structured into five sections. Following this introduction, Section two presents a literature review that defines the MD and its relevance to sustainable tourism, with a focus on dietary and gastronomic innovation. Section three outlines the mixed-methods research design. Section four discusses the findings in relation to the applied methodologies. Finally, Section five offers conclusions and directions for future research.

LITERATURE REVIEW

The Mediterranean Diet and its relevance in sustainable tourism

Gastronomy is increasingly acknowledged as a vital component of cultural heritage, offering distinctive experiences that reflect a region's culinary traditions, local ingredients, and cultural values. As such, it holds significant potential to contribute to the achievement of the Sustainable Development Goals (SDGs) within the tourism sector, presenting strategic opportunities for both the industry and society (Fennell & Bowyer, 2020). The evolution of gastronomic tourism now encompasses ethical and sustainable values linked to territory, landscape, local history, and cultural heritage, aligning with the overarching objectives of sustainable tourism (Güneş, 2013; Jantsch et al., 2024).

Food constitutes a central element of the tourism experience, influencing destination choice and encompassing a wide range of products and services. Within this framework, gastronomy and wine play pivotal roles, with the "Mediterranean trilogy" of bread, olive oil, and wine symbolizing the Mediterranean lifestyle (Sánchez-Hernández, 2023). This trilogy represents key elements of food culture, ease of consumption, and primary drivers for innovation in the Mediterranean Diet, embodying the principle of frugality. These are the core components of the MD, which were first inscribed by UNESCO in 2010 as Intangible Cultural Heritage of Humanity through a multinational nomination involving Spain, Greece, Italy, and Morocco (UNESCO, 2024). In subsequent years, the inscription was extended to include additional Mediterranean countries, with Portugal–represented by the municipality of Tavira as its emblematic community–joining this transnational framework. This progressive enlargement reflects the MD's nature as a living heritage shared across the Mediterranean basin, adapting to different territorial contexts while maintaining its core principles. The MD is more than a dietary pattern; it is a lifestyle that encapsulates the cultural identity of Mediterranean communities, centered on shared food experiences (Graça, 2014).

The MD is defined as a time-honored dietary model characterized by the consumption of olive oil, cereals, fruits, vegetables, fish, dairy, meat, and wine or herbal infusions, with an emphasis on seasonal and locally sourced products (APN, 2023). This model not only promotes health but also supports environmental sustainability and a lifestyle rooted in tradition and conviviality (Graça, 2014; Keys, 1975; Serra-Majem et al., 2020). Integrating the MD into tourism strategies offers a pathway to sustainable development by leveraging local resources and cultural heritage (Covas & Covas, 2015).

Real et al. (2021) describe the MD as a complex and evolving concept, shaped by intergenerational transmission and adaptation. It encompasses multiple interconnected domains, including culture, education, environment, health, the food industry, tourism, and sustainability, all of which are underpinned by MD principles.

Innovation in the Mediterranean Diet: A pathway to sustainable development

Innovation within the MD framework entails generating value through the creation of new products and services that honor traditional practices while incorporating contemporary techniques and consumer preferences. This can be achieved through the development of thematic networks, value chains, and marketing strategies that highlight the distinctive attributes of MD-related products (Gonçalves et al., 2023). For example, the Mediterranean trilogy–bread, olive oil, and wine–serves as a foundation for culinary innovation that emphasizes quality, authenticity, and sustainability (Bernardes & Oliveira, 2015). This food matrix represents a nutritionally balanced model that promotes health and enhances quality of life (Mateus, 2015).

Recent studies suggest that innovation in the gastronomic sector, particularly within the MD context, can enhance the reputation and economic resilience of regions such as the Algarve. Small enterprises stand to benefit from adopting innovative practices in product development, management, and marketing (Bhaskaran, 2006; Hjalager, 2022). Sensory elements such as taste, texture, and presentation are critical to this experience and significantly influence tourist satisfaction and perception (Fiorentini et al., 2020; Lee, 2023; Moreno-Lobato et al., 2024).

Innovation in gastronomic tourism can manifest across multiple dimensions, encompassing product, process, experiential, and marketing innovations (Hjalager, 2010). In the context of the Mediterranean Diet, concrete examples illustrate this diversity. Product innovation involves creating new food items using traditional ingredients, such as developing a spreadable olive oil cream (as in the present study), carob-based desserts, repositioning a traditional animal feed as a gourmet ingredient, or craft beers infused with Mediterranean herbs and fruits. Process innovation refers to new methods of production or preservation, including the use of methylcellulose to create textural variations in olive oil, fermentation techniques for vegetable preservation, or cold extraction methods for almond-based beverages. Experiential innovation focuses on how gastronomy is delivered and consumed, exemplified by immersive dining experiences where chefs explain the cultural significance of each dish, food-and-wine pairing events in authentic settings (olive groves, vineyards), or storytelling menus that narrate the history of local products. Marketing innovation includes the strategic use of Protected Geographical Indications (PGI) to communicate authenticity and quality, digital storytelling through social media platforms to engage tourists before arrival, and the creation of gastronomic routes that connect producers, restaurants, and cultural sites. These examples demonstrate that innovation within the MD need not imply a departure from tradition, but rather a creative reinterpretation that enhances consumer experience while preserving cultural integrity.

Integrating MD principles into gastronomic tourism presents opportunities for innovation and the creation of new experiences that appeal to both residents and visitors. This integration can be supported by sensory science and the development of culinary products that respect tradition while embracing modernity (Gonçalves et al., 2023).

Recent research highlights that perceptions of innovation differ between firms and consumers. While companies tend to focus on technical and functional aspects, consumers prioritize the creation and delivery of novel experiences (FAO, 2022; Kandampully et al., 2023). The success of such innovations depends on a nuanced understanding of consumer preferences, which can be effectively assessed through sentiment analysis of social media content (Rita et al., 2023).

Sentiment analysis and the enhancement of the gastronomic experience

Understanding and responding to consumer preferences is essential for the success of gastronomic tourism initiatives. In recent years, sentiment analysis has emerged as a valuable tool for evaluating consumer attitudes and preferences, particularly through social media platforms. By analyzing sentiments expressed in online reviews and posts, tourism stakeholders can gain insights into what tourists value most in their culinary experiences and identify opportunities for innovation and enhancement (Surugiu et al., 2023).

Sentiment analysis enables the assessment of tourists' perceptions of MD-related products and services, offering a data-driven approach to improving gastronomic tourism. By identifying key factors that influence tourist satisfaction–such as the quality of local ingredients, the authenticity of the culinary experience, and the overall ambiance–stakeholders can develop targeted strategies to enhance these elements and create more attractive, sustainable offerings (Rita et al., 2023). The integration of sentiment analysis into gastronomic tourism development represents a novel approach to understanding and meeting tourist expectations. This method not only supports regional sustainable development but also contributes to the preservation of cultural heritage and the enrichment of the gastronomic tourism experience.

Gastronomy is often seen as an experience that transcends tourism (Recuero-Virto & Valilla Arróspide, 2024). Indeed, as Yeoman (2012) notes, food offers tourists new tastes, knowledge, and concepts, and presents itself as a symbol

in the experience economy. Discovering a destination through its cuisine is an exciting and satisfying experience, and it is also provocative for visitors in the age of globalization.

Cardello and Maller (1982) conducted a study to evaluate the relationships between food preference classifications and food acceptability classifications, using both a laboratory panel of expert tasters and a field survey panel of consumers (Cardello, 2020). Their findings revealed strong correlations between the two panels' preference ratings, despite the laboratory panel assigning systematically higher absolute scores. This indicates that while the intensity of preference may differ between settings–with experts in controlled environments tending to rate products more favorably–the ordinal pattern of preferences (which products are preferred over others) remains consistent across laboratory and real-world contexts. This methodological insight is particularly relevant for the present study, as it justifies the sequential integration of expert-led sensory tastings (Phase 3, conducted in a laboratory setting) and subsequent small-scale acceptability tests with actual consumers (Phase 4, conducted in a real restaurant environment). The expected correlation between these phases, as predicted by Cardello and Maller (1982), validates the use of expert panels as an efficient filter for identifying promising combinations before progressing to more resource-intensive consumer testing, while also reinforcing the reliability of the overall mixed-methods approach.

Consumer preferences evolve as sensory knowledge and training develop (Cliff et al., 2016; Nervo et al., 2024). According to Gomez and Spielmann (2019), associating a food product with a group of influencers increases flavor perceptions across various food categories, suggesting that the taste experience is enhanced when foods embody the characteristics of the social elite.

This research offers a novel approach to understanding and responding to tourist preferences, supporting sustainable tourism by developing products and services that align with MD cultural heritage while meeting the demand for authentic, sustainable travel experiences. Promoting food innovation, preserving cultural heritage, enhancing sustainability, and improving the tourist experience contribute to endorsing cultural practices. MD has gained prominence as a healthy, sustainable lifestyle that can enhance regional well-being and development. This approach supports economic growth through innovative gastronomy, aligning with global sustainability goals.

METHODOLOGY

Research context

The Algarve region is notable for its distinctive fruit genetic heritage, which sets it apart from other Portuguese regions. Economically, the Algarve is a relatively small region, contributing approximately 4.8% to the national GDP in 2019, with steady growth observed since 2014 (CCDR Algarve, 2024).

Gastronomy and wine have become central components of the Algarve's tourism offering, gaining international recognition and enhancing the region's appeal year-round. This strategy helps to mitigate seasonality, encourages sustainable consumption, and reinforces the principles of the MD, which are essential for reducing the regional ecological footprint and progressing towards carbon neutrality (CCDR Algarve, 2024). For this study, the municipality of Tavira, in the Algarve, was selected as the research setting. Tavira holds a distinctive position within the Portuguese narrative of the MD, having been recognized as a representative community following Portugal's integration into the multinational UNESCO inscription–originally established in 2010 and subsequently extended to include other Mediterranean States (UNESCO, 2024).

Portugal is home to more than one dietary pattern. The Atlantic Diet, predominant in the north and center, features fish, seafood, dairy and beef, distinguishing it from the Mediterranean triad. However, the Algarve and Tavira were selected as a case study for innovation in the MD based on specific criteria. First, UNESCO's formal recognition of Tavira as a representative MD community confers unique authenticity to its heritage (UNESCO, 2024). Second, the region's edaphoclimatic conditions enable cultivation of key MD elements–almond, fig, carob, and grapevines (Costa & Rosa, 2020a, 2020b)–providing an endogenous resource base for innovation. Third, the region's economic dependence on tourism makes developing sustainable offerings that valorize this cultural heritage both urgent and strategic. Thus, the Algarve constitutes a privileged 'living laboratory' for exploring the MD's innovation potential within tourism.

Research objectives

The central research question guiding this study is: How can consumer insights derived from sentiment analysis guide the innovation of appetizers based on the MD to enhance the gastronomic tourism offer in Tavira, Algarve? This overarching question is addressed through three specific objectives:

1) Identify the sensory and experiential factors most valued by tourists through sentiment analysis of online reviews.
2) Map and select local, MD-aligned resources with innovation potential.
3) Co-create and evaluate a set of innovative appetizers with experts, based on the integrated findings.

To achieve these aims, a four-step methodological framework was developed. Sensory analysis was conducted in conjunction with the Delphi technique, enabling expert collaboration in identifying innovative opportunities in gastronomy and wine pairings. This combined approach provided a comprehensive understanding of both consumer sentiment and expert perspectives, informing the development of novel Mediterranean culinary experiences.

Study design

A mixed-methods approach–integrating both qualitative and quantitative methodologies–was employed to investigate the incorporation of the MD into gastronomic tourism, with a particular focus on sentiment analysis, expert insights, and tourist perceptions. The methodology followed a four-step sequence, illustrated in Figure 1. It began with sentiment analysis of enogastronomic experiences shared on social media (Step 1), followed by the mapping of endogenous resources: A Network Approach to Grounding Innovation in Territorial Assets (Step 2). A focus group with experts, using the Delphi method, was then conducted to evaluate innovative delicacies (Step 3). Based on these insights, a gastronomic experience was designed and implemented in a local restaurant (Step 4).

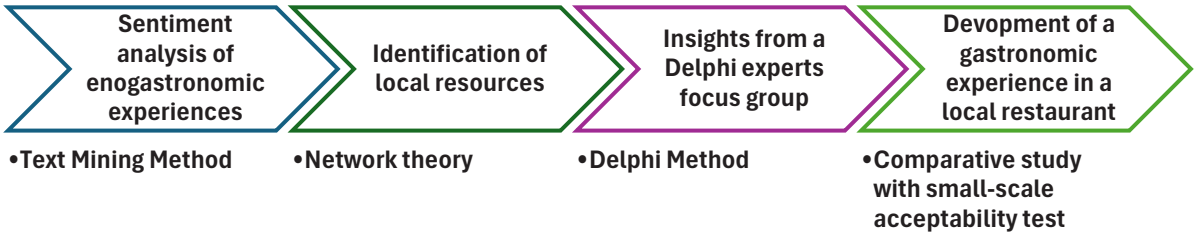


Figure 1. Theoretical framework of the research

The integration of sentiment analysis with expert-led focus group discussions enabled a holistic understanding of consumer expectations and expert recommendations. This methodological design facilitated the identification of innovation opportunities within the MD framework, contributing to the sustainable development of gastronomic tourism in the Algarve.

To ensure methodological coherence, it is important to articulate how sentiment analysis results are operationalized in subsequent phases. Sentiment analysis functions not merely as a contextual framework, but as a genuine analytical driver that helps define concrete experimental decisions. The identification of the Mediterranean trilogy element with the lowest sentiment score signals an innovation opportunity, leading to the development of distinct products based on the trilogy element and that were tested with new sensory combinations, through the selection of aromatic herbs (basil, thyme, oregano, pennyroyal), as well tested by the experts' evaluation criteria ('texture', 'flavours', 'taste/aroma'). Thus, sentiment analysis will serve as the empirical foundation for culinary creativity, ensuring that innovations respond to genuine consumer preferences rather than solely to the researcher's intuition.

It is critical to clarify the evidentiary weight assigned to the sentiment analysis. The sentiment scores are not definitive measures of product deficiency or standalone evidence of innovation. Rather, they function as exploratory signals that inform hypothesis generation. The subsequent phases (expert validation and consumer testing) serve as confirmatory mechanisms. This sequential logic follows the principle of "exploration followed by confirmation" (Tukey, 1977), in which digital trace data generates research questions that are then tested through controlled sensory evaluations and real-

world acceptability trials. The inference that a product represents an innovation opportunity is therefore not drawn from sentiment analysis alone, but from the convergence of three distinct data sources: (i) the comparatively lower sentiment score; (ii) expert identification of product-texture modifications as a promising design space during the Delphi session; and (iii) consumer feedback during the small-scale acceptability test. This triangulation strengthens the validity of the conclusion beyond what sentiment analysis alone could provide. To ensure methodological transparency and clarify the analytical logic underpinning this study, the specific role and contribution of each methodological component are explicitly articulated as follows:

Sentiment Analysis (Step 1): Serves as the diagnostic and exploratory phase. Its specific role is to systematically capture the 'voice of the customer' by identifying the sensory attributes, products, and experiential dimensions (e.g., taste, environment, specific foods like bread) that most significantly influence tourist satisfaction and reveal opportunities for innovation. The output is a data-driven understanding of consumer preferences, which directly informs the subsequent creative phase.

Identification and Mapping of Local Resources (Step 2): Functions as the contextual and supply-side inventory phase. Its specific role is to ground the innovation process in the region's tangible assets. By cataloging indigenous species, traditional products, and local producers, this component ensures that any new gastronomic creation is authentic, feasible, and leverages the unique biodiversity of the Algarve, aligning with the principles of the MD.

Sensory Tastings with Experts (Delphi in a Group - Step 3): Acts as the validation and co-creation phase. This component translates the consumer insights (from Step 1) and the regional resources (from Step 2) into tangible products. The specific role of the expert panel is to evaluate and refine potential ingredient combinations (bread base, innovative element, aromatic herb) to ensure culinary harmony and quality before public testing. The output is a refined, expert-approved tasting menu.

Small-Scale Acceptability Test (Step 4): Represents the real-world testing and market validation phase. Its specific role is to measure the actual consumer response–both national and international–to the proposed gastronomic experience in an authentic restaurant setting. This provides preliminary evidence of the menu's commercial viability and tourist appeal, closing the loop between consumer insights and the final innovative offering.

In summary, the methodology follows a logical progression from diagnosing consumer preferences (Step 1) and auditing local assets (Step 2) to co-creating a prototype with experts (Step 3) and finally validating that prototype with the target audience (Step 4). This sequential integration ensures that each phase builds upon the previous one, collectively answering the research question of how to innovate within the MD.

Sentiment analysis applied to Mediterranean gastronomy experiences

Sentiment analysis was conducted on a dataset comprising social media posts and online reviews related to enogastronomic experiences in the Algarve. The objective was to identify key elements influencing tourists' perceptions and preferences regarding MD-related products and services. Natural Language Processing (NLP) techniques were employed to extract sentiments, which were subsequently categorized into thematic areas reflecting tourist satisfaction and potential avenues for innovation.

Text mining techniques were used to analyze tourists' sentiments concerning their experiences with Mediterranean cuisine. This approach enabled the identification of prevailing attitudes and preferences towards the MD.

The sentiment analysis methodology was adapted from El-Masri et al. (2017: 54) and further informed by Jiang et al. (2021). It followed five key stages: data collection, data processing, feature extraction, application of a text mining algorithm, and evaluation of results.

Data collect

Restaurants in the municipality of Tavira, with a presence on TripAdvisor (2023), were considered. To select restaurants, the search criteria included "Tavira," which offered "Mediterranean" cuisine, resulting in 38 restaurants, for which 30 comments were automatically collected, each in English. Only comments in English were considered, as English is regarded as the lingua franca of international tourism, and, given the intention to use the VADER algorithm, this tool is only optimized for the English language, ensuring validity and reliability. Furthermore, studies suggest that translating comments from other languages before conducting sentiment analysis is inadvisable, as each language has its own linguistic structure; therefore, comments in other languages were not considered.

The most widely adopted social media platform is TripAdvisor, both for analyzing hotel and restaurant reviews and for gastronomy, as considered by some researchers (Agüero-Torales et al., 2019; Chang et al., 2019; Marcos & Ramos, 2023). Comments expressed in languages other than English were not considered, as they would not allow for linguistic analysis with the same structure and vocabulary. In total, 1,050 valid comments in English were collected from thirty-five restaurants. The set of restaurants analyzed (35) represents nearly all Mediterranean cuisine establishments in Tavira with a significant online presence (a census approach).

The data collection was conducted in September, 2024, extracting reviews from TripAdvisor for restaurants in the Tavira municipality classified under "Mediterranean cuisine". The search initially returned 38 establishments. One restaurant was excluded because it had fewer than 30 English reviews (n=12), and two additional restaurants were excluded because they had ceased operations at the time of data collection, as confirmed by direct contact. Consequently, 35 restaurants met the inclusion criteria. For each of these 35 restaurants, the 30 most recent English-language reviews available on TripAdvisor as of the collection date were automatically retrieved, yielding a total of 1,050 unique reviews. No reviews were duplicated across restaurants. The collection date was recorded to enable temporal contextualization of findings.

Regarding the characterization of the restaurant ratings (n=35), Table 1 presents descriptive statistics for the categories: food, service, value, environment, and global classification, based on the ratings on the website for each restaurant. These classifications are the original ones and have not been standardized.

Table 1. Descriptive statistics of the scores given to restaurants by category

	Minimum	Maximum	Average	Standard Deviation
Global	4	5	4.40	0.29
Food	4	5	4.47	0.30
Service	3.5	5	4.41	0.37
Value	3.5	5	4.39	0.37
Environment	2.5	5	4.23	0.52

Data processing and feature extraction

To analyze the data, it was necessary to carry out some processing on the data (El-Masri et al., 2017) by eliminating electronic addresses, transforming all words into lowercase, eliminating numbers in Arabic, and identifying stop words, so that they were not considered in the word cloud, shown in Figure 2, which allows for exploratory analysis of the words with the highest frequency. When analyzing Figure 2, which shows only the words with the highest frequency, the words "great food", "good food", "food great", "delicious food" and "excellent food" are prominent, reflecting the gastronomic experience. In terms of food, the gastronomic products 'fish' stand out. Finally, it is worth highlighting the frequency of the word "delicious", which emphasizes the taste associated with the gastronomic experience. Figure 3 illustrates the categories corresponding to the considered characteristics.

Figure 2. Word cloud of all comments about the gastronomic experience of the restaurants in Tavira considered in the present study

At the review level, duplicate detection was performed by comparing review text, author identifier (anonymized), and timestamp. No exact duplicates were identified within the dataset. Near-duplicates (e.g., identical text posted by different users) were retained as they represent independent consumer opinions.

The VADER algorithm inherently accounts for negation through its rule-based approach (e.g., "not good" receives a negative compound score). However, to validate VADER's performance on our specific domain, a random sample of 200 reviews (approximately 19% of the corpus) was manually annotated by two independent coders (inter-rater reliability: Cohen's $\kappa = 0.84$). The agreement between VADER classification and human coding was 87.5% (F1-score: 0.88), confirming the algorithm's adequacy for this context.

For category-specific sentiment extraction (e.g., "bread", "wine"), we employed exact string matching with lemmatization (e.g., "breads", "bread's" mapped to "bread"). Co-occurrence within a five-word window was required to attribute sentiment to a specific category.

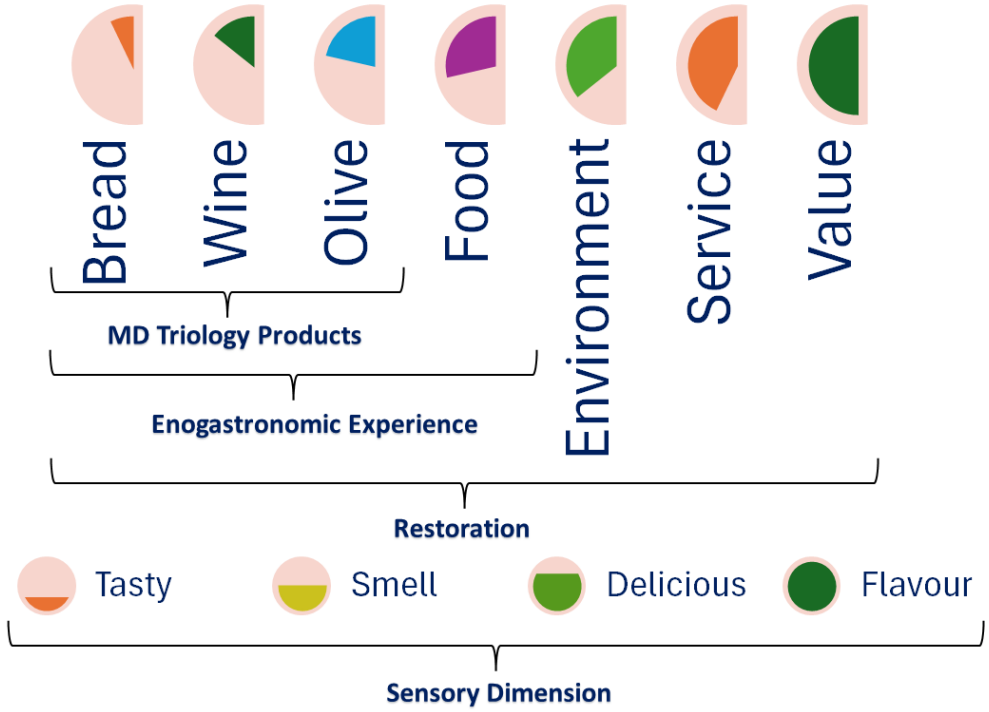


Figure 3. Categories of characteristics considered

In terms of the stage related to the extraction of features, and in the future considered as aspects to be analyzed by the text mining algorithm, in relation to the detection of the associated sentiment, four categories were considered:

- trilogy of products: Olive oil, bread, and cereals (bread) and wine;
- enogastronomic experience, which includes food related to the trilogy;
- restaurant experience, which considers food, value, environment, and service, making it possible to make a comparison with the ratings given and shared on TripAdvisor, and
- the sensory dimension through the words "smell", "delicious", "tasty" and "flavour."

Application of the Text Mining Algorithm and results evaluation

For the text mining algorithm used for sentiment analysis, VADER was applied (Hutto & Gilbert, 2014). The sentiment was calculated based on polarity, which ranges from -1 (most negative sentiment) to +1 (most positive sentiment). The keyword-guided sentiment scoring using VADER was considered, enabling sentiment analysis of the characteristics of the categories presented above.

To facilitate comparison between the scores presented on the TripAdvisor website and the sentiment, the sentiment was normalized to a scale of 0 to 5, just like the scores, making the results more intuitive and informative. The results of the sentiment analysis and its normalization are presented in the next section. To carry out the normalization, the formula adapted from Chen et al. (2020, p. 9) and multiplied by the upper limit (*j),* which in this case takes the value of 5, was considered, and presented in equation (1):

$$x_i' = \frac{x_i - x_{min}}{x_{max} - x_{min}} * j \quad (1)$$

To exemplify the normalization process, the sentence "*Very nice local dishes from a very pleasant but small restaurant in a great location by the Roman Bridge. The service is excellent and extremely courteous. Great value for money. The food is unpretentious but fresh and well presented.*" obtained a sentiment value of 0.9892, on a scale of -1 to +1, which, when normalized, obtained a value of 4.973, on a scale of 0 to 5.

Mapping endogenous resources: A network approach to grounding innovation in territorial assets

To strengthen the research, it was essential to make a diagnosis of existing research (Table 2), which aims to identify indigenous resources in the Algarve, promote short marketing chains and test and experiment with new food products linked to the MD. Producers were included in the inventory if they met the following criteria: (i) location within one of the 16 municipalities of the Algarve; (ii) self-declared or certified organic, family-based, small-scale, integrated, or traditional production methods; (iii) presence in the 'Banco de Produtores' of the 'Prato Certo' platform (BPALS, 2023); and (iv) where applicable, association with Controlled Denomination of Origin (CDO), GPI, or Guaranteed Traditional Speciality (GTS) certifications, as verified through official certification registers. Duplicate entries were identified and removed through manual inspection of producer names, locations, and product types.

The inventory of endogenous resources (Table 2) serves not merely as a descriptive catalog, but as the empirical foundation for selecting ingredients with innovation potential. To move from a simple list to an understanding of how these resources are valorized, network theory was considered. This approach, used in flavor science (Ahn et al., 2011) and in alternative food systems (Brinkley, 2018), allows for the visualization of relationships between local products and their recognized quality seals (CDO, PGI, GTS). The resulting network graph (Figure 4) illustrates the connections between the Algarve's genetic heritage and its certified traditional products. This analysis fulfills two specific functions within the overall research design:

Justification of Ingredient Selection: By identifying products with high relational density (e.g., carob, almonds, goat cheese), the network analysis provided a data-driven rationale for focusing the subsequent innovation phase on these specific resources, rather than on arbitrary choices. The selection of carob for the semifreddo, goat cheese for the cream, and the focus on local aromatic herbs were thus informed by their embeddedness in the regional certification network.

Identification of Valorization Gaps: The network also reveals products with high biodiversity (e.g., the 99 varieties of almond trees) but low certification density, pointing to opportunities for future innovation through the development of new protected designations or value-added products, a point addressed in the study's implications for future research.

Consequently, this section does not function as an independent territorial diagnosis, but as the supply-side counterpart to the demand-side insights derived from sentiment analysis.

Table 2. Identification of varieties by genetic material type - Algarve

Varieties (Breeds | Species | Castes)	Typology (Autochthonous / Traditional)
Cattle	1
Sheep	2
Goats	2
Pork	4
Chicken	2
River fish	11
Sea fish	43
Univalves / Bivalves	10
Cephalopods	5

Varieties (Breeds | Species | Castes)	Typology (Autochthonous / Traditional)
Crustaceans	11
Dryland Almond trees	99
Dryland Fig trees	85
Dryland Carob trees	15
Olives trees	22
Citrus	38
Vines (Vitis vinifera)	75
Arbutus berry "Medronho"	1
Vegetables, aromatics, pulses and other vegetables	102
Bee farming	6
Salt farming	5
Bakery / Patisserie	16

Note: Counts are compiled from official agricultural inventories (DGADR, 2024), regional varietal catalogs for almond, fig, carob, and olive trees (Costa & Rosa, 2020a, 2020b), biodiversity records for marine and freshwater species, and certification registers for CDO/PGI/GTS products.

Data collect

With the aim of mapping the resources, including local producers and suppliers, available in the region (BPALS, 2023), with 252 producers characterized as organic, family, small-scale, integrated, and traditional production (CDO, PGI, and GTS). It was also found that there is a need for additional research, particularly on species and breeds indigenous to the Algarve (Table 2) (Costa & Rosa, 2020a, 2020b; CVA, 2024; DGADR, 2024).

Resource mapping

The theory of complex networks presents the network as a graph, where nodes and edges connect these nodes, representing the relationships between them, and its application is transversal to numerous areas of research (Bastian et al., 2009). The cultural diversity of culinary practice, illustrated by regional cuisines, raises the question of whether there are general standards that determine ingredient combinations, or principles that transcend individual tastes and recipes.

After identifying the main native and traditional resources of the Algarve and their varieties, it was considered to analyze their relationship with certified traditional products that bear the nomenclatures CDO, PGI, and GTS. Considering that the Gephi program is an open-source platform for creating network visualization graphs (Bastian et al., 2009), its use was considered, as it enables examining the most influential network connections and those that require greater dynamics. The results are presented in a simple, undirected graph (Figure 4), with at most one edge between any two nodes (no parallel edges). This descriptive visualization was used solely as a heuristic aid to guide ingredient selection qualitatively. Carob and goat cheese were chosen based on their frequency of association with certified products and their cultural relevance in the Algarve, not on formal network metrics, while the certification gap for almonds suggested a longer-term opportunity beyond the scope of the present study. Thus, the network mapping functioned as a supply-side complement to the demand-side insights derived from sentiment analysis, helping to ground the innovation process in territorially authentic assets.

Figure 4 presents an exploratory network visualization of relationships between the Algarve's genetic heritage (varieties) and certified traditional products (CDO, PGI, GTS). This heuristic map illustrates certification density (e.g., carob, citrus, wines) and gaps (e.g., almonds, figs), informing ingredient selection for subsequent innovation phases. No statistical network metrics were computed.

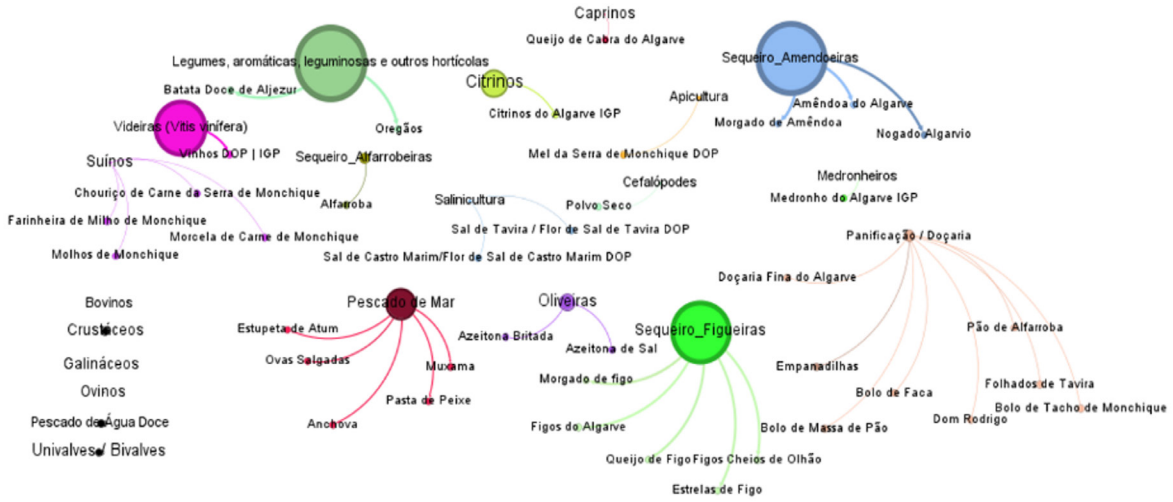


Figure 4. Resource mapping – Diagnosis of varieties vs. traditional CDO products, PGI, and GTS

Legend: Exploratory and descriptive visualization of the relationships between endogenous varieties of the Algarve and certified products (CDO, PGI, GTS). No statistical network metrics were computed. The graph serves exclusively as a heuristic support for ingredient selection in subsequent phases.

Sensory tastings with experts

To complement the insights from sentiment analysis and resource mapping, a sequential, multi-phase approach was designed to yield tangible gastronomic innovations. This approach comprised: (i) prototype development in a food engineering laboratory, where ingredients were selected based on prior findings; (ii) expert validation using a Delphi-in-a-group format to refine combinations; and (iii) a small-scale consumer acceptability test in a real restaurant setting to assess market potential. This sequential logic ensures that each phase is analytically grounded in the previous one, creating a clear pathway from consumer diagnosis to product validation.

Phase 1: Prototype Design and Laboratory Development

The selection of ingredients and the design of innovative prototypes were directly informed by the study's preceding phases. It should be noted that the lower sentiment score for bread was interpreted not as a direct mandate to innovate the bread product itself, but rather as a heuristic prompt to explore bread-based formats and pairings as potential vehicles for delivering the core innovations (spreadable olive oil, goat cheese cream, carob semifreddo). This interpretation is consistent with the view that bread's role in the Mediterranean meal is often functional and ancillary; enhancing its sensory contribution may therefore lie in its interaction with other elements rather than in modifications to the bread alone. Competitionally, resource mapping (Step 2) highlights the abundance and cultural relevance of carob, goat cheese, and local aromatic herbs (basil, thyme, oregano, pennyroyal) as key endogenous assets with innovation potential (Table 2).

Based on these combined insights, prototypes were created in a university food engineering laboratory to explore optimal combinations of innovative, natural-origin ingredients with emulsifying, gelling, and stabilizing properties. The objective is to modify the textures of traditional foods associated with the Algarve's MD to create new sensory experiences. Based on the concepts of the MD and Table 2, the following products were considered for prototype development: olive oil, goat cheese, and carob.

Phase 2: Expert Validation through Delphi in a Group

To technically validate the prototypes and identify the most promising combinations, a focus group was considered. This was agreed upon using the "Delphi method in a non-anonymous group" (Van Zolingen & Klaassen, 2003; Serra, 2016). This method was chosen to achieve rapid expert convergence through iterative and real-time feedback in a structured setting.

Six experts with recognized knowledge in gastronomy and enology and a history of evaluating taste sensations were invited to participate in a face-to-face tasting session, which was structured around three key sensory attributes–texture, flavors, and taste/aroma–and were considered a hedonic preference scale from 1 to 9 (Alvelos, 2002). Data were collected via an online questionnaire during the session to ensure consistency and facilitate immediate analysis.

To mitigate dominance effects, individual ratings were collected anonymously via an online questionnaire before any group discussion. Consensus was assessed using average absolute deviation from the median (AAD), with a threshold of ≤1.0 on the 9-point scale. Mean AAD was 0.58 (texture), 0.62 (flavors), and 0.71 (taste/aroma). Inter-rater reliability (Fleiss' κ) was 0.73 (95% CI: 0.67–0.79), indicating substantial agreement.

Phase 3: Small-Scale Acceptability Test in a Real Restaurant Setting

The final phase aims to validate the expert-approved combinations in a real-world consumption context, following the methodological principle established by Cardello and Maller (1982), which holds that laboratory-based preferences reliably predict field preferences. Based on the expert voting results, the most voted combinations for each innovative element were selected to compose a tasting menu.

A local restaurant with a strong regional identity was invited to prepare and serve the tasting menu. Fifty participants (25 Portuguese and 25 international tourists) were recruited to evaluate the five elements of the tasting menu. Participants will rate their overall liking for each element of the tasting menu using the same 9-point hedonic scale (Alvelos, 2002). Responses were collected via an online questionnaire (Google Forms) immediately after tasting. This test will serve as an exploratory validation of the products' appeal and market potential, providing preliminary evidence of how the consumer-driven, expert-refined innovations were received by the target audience.

A convenience sample of 50 participants–25 Portuguese and 25 international tourists–was recruited on-site over three days. Eligibility criteria included age of at least 18 years, absence of any allergy to the ingredients used, and, for tourists, self-declared non-residence in Portugal. The five appetizers were served in a randomized order to each participant, following a Latin square design generated in R, under single-blind conditions (three-digit codes only). Between tastings, participants cleansed their palate with 20 mL of still water, waited 60 seconds, and were offered a plain cracker if desired. Portions were standardized as follows: olive oil spreads (15 g), goat cheese creams (18 g), and carob semifreddo (25 g); bread bases were cut to 1 cm thickness and 25 cm^2 surface area. Hot appetizers were served at 55–60°C and cold ones at 4–6°C.

Ethical considerations

This study was conducted in accordance with ethical principles for research involving publicly available data and human participants. For the sentiment analysis phase, only publicly accessible TripAdvisor restaurant reviews were collected. No personally identifiable information (e.g., usernames, profile details) was retained; only the textual content of reviews and aggregated metadata (ratings) were analyzed. The data collection complied with TripAdvisor's terms of service regarding automated access at the time of collection, and no attempt was made to circumvent access restrictions or to collect non-public data.

For the small-scale acceptability test conducted in a restaurant setting, all participants were informed of the study's purpose, the voluntary nature of their participation, and their right to withdraw at any time without consequences. Written informed consent was obtained from each participant prior to tasting. No incentives were offered that could constitute undue influence; participation was entirely voluntary and took place in a normal dining context. The study protocol was reviewed and found exempt from full review on the grounds that it involved minimal risk, anonymized data collection, and standard sensory evaluation procedures with healthy adult volunteers. All data was anonymized at the point of collection, and no individual responses can be traced back to participants.

RESULTS

Sentiment analysis applied to Mediterranean gastronomy experiences

To present the results obtained with the application of Sentiment Analysis methods in an approach with text mining algorithms, the categories to be investigated were considered, which were previously presented: i) Trilogy of products (Figure 5), (ii) Restaurant experience (Figure 6) and (iii) the Sensory dimension (Figure 7).

Figure 5 presents the average sentiment associated with MD trilogy products. The values obtained for evaluating the sentiment expressed online were 4.6 for wine and olive oil, a result near the top of the scale. At the same time, bread recorded an average sentiment score of 4.2, compared to 4.6 for olive oil and wine. While this difference does not in itself demonstrate an 'innovation deficit', it offers an exploratory signal that bread-based formats and pairings may represent an underexplored design space for enhancing the gastronomic experience, particularly when combined with the highly valued elements of olive oil and wine.

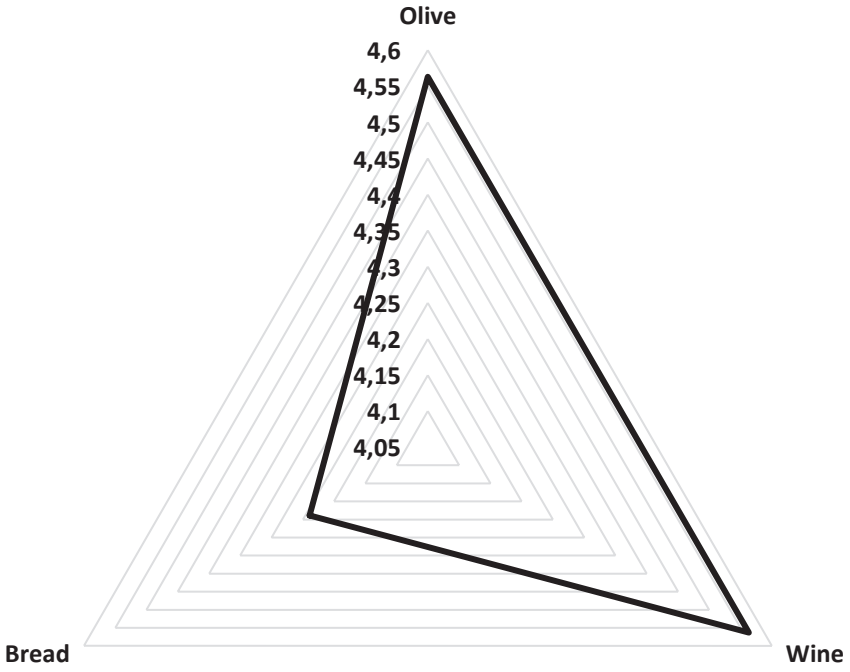
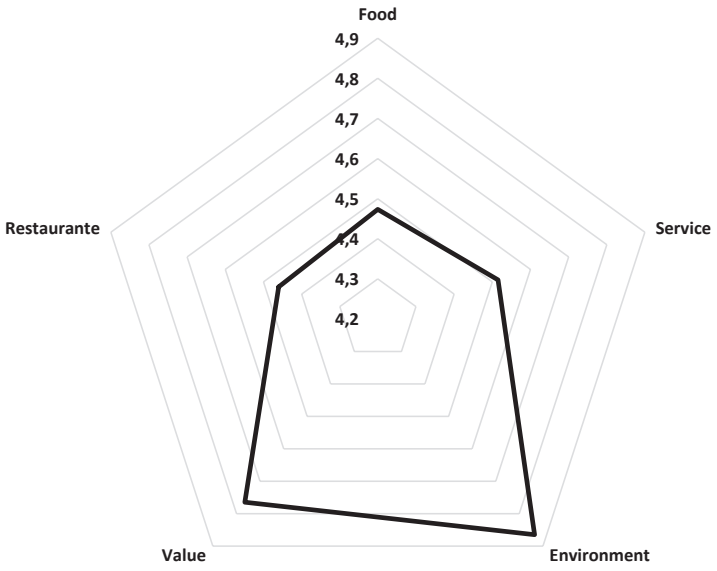


Figure 5. Average sentiment associated with the MD trilogy products
Note: Higher scores indicate more positive sentiment.

Figure 6 presents the average sentiment associated with MD restaurants across environment, service, value, food, and the overall restaurant experience. Characteristics associated with food, service, and customer value were considered, and TripAdvisor sentiments were analyzed and standardized on a scale of 1 to 5. The restaurant environment received the highest rating, around 4.9, possibly reflecting the social dimension and conviviality. This was followed by a customer value of around 4.8, indicative of the overall tourist experience. The service received a rating of 4.4, which should be analyzed in detail to understand the evaluation. The food received a rating of 4.3, highlighting the need to understand which characteristics are least valued sentimentally. However, the restaurant's sentiment score was below 4.4. When assessing these values, the environment stands out with a high score, while the restaurant, food, and service have lower scores. Therefore, comments on these aspects should be analyzed in detail, especially those with lower sentiment scores. For example, the quality of the service may be important, while the restaurant's ambiance may be associated with its decor.

Figure 7 presents the results associated with the average sentiment of MD restaurants' sensory dimensions. Aspects related to odor (smell) and taste (delicious, flavor, and taste) were considered, while touch, sight, and hearing were not. The scores obtained to assess sentiment on the sensory dimension showed that "delicious" had the highest average sentiment value of 4.7, followed by "tasty" at 4.6. However, "tasty" had a lower average sentiment of 4.2; comments where this aspect appears should be analyzed in detail, as they may reflect less valued statements about taste. The "flavor" aspect had an average sentiment value of 4.6.

As tourism is an information-intensive sector, the proliferation of analyses of comments from tourists in the digital environment cannot be ignored, as they enable the aggregation of meaningful relationships that will contribute to the evaluation of products and services related to MD. The sentiments expressed in social networks related to gastronomy can be detected and contribute to the definition of new strategies for gastronomic innovation in MD.



Note: Higher scores indicate more positive sentiment.

Figure 6. Average sentiment associated with the characteristics associated with MD restaurants

Innovation in gastronomy can be found in terms of dishes, ingredients, services (Bertan, 2020) or other characteristics considered relevant to MD, through the methodology associated with the analysis that allowed answering the research question "How can consumer insights, derived from sentiment analysis, guide the innovation of appetisers based on the MD to enhance the gastronomic tourism offer in Tavira, Algarve?" gastronomic dimension, through the approach defined by Gonçalves et al. (2023), which highlights the importance of understanding what the consumer is looking for and the need to focus on quality.

In Figure 8, the developed framework identified the components with the highest sentiment values: olive oil and wine (most positive), and bread, an area with space for improvement/innovation.

The results presented in Figure 8 for each of the categories studied show that there are aspects to improve on quality and the associated sentiments, i.e. where there is a possibility for innovation, such as in the MD trilogy: bread; in the restaurant: food and service; in the sensory dimension: "tasty." The environment and the value consumers attribute to the restaurant stand out as aspects with very high average sentiment.

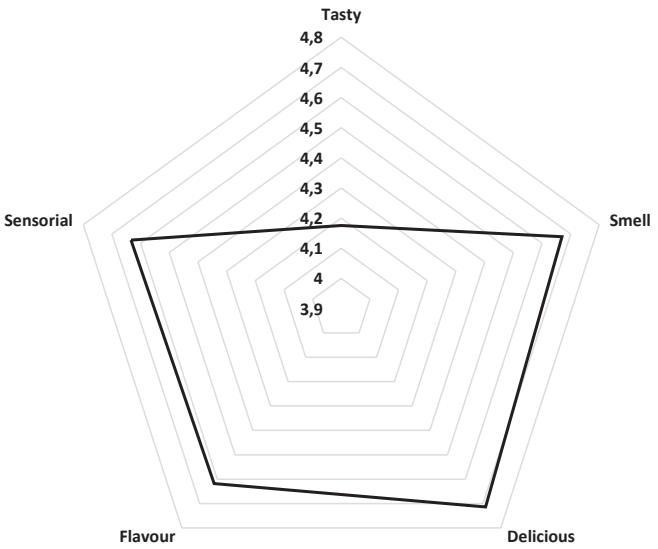


Figure 7. Average sentiment associated with the MD restaurants sensory dimensions.

Note: Higher scores indicate more positive sentiment.

Finally, Figure 8 presents a comparative synthesis of sentiment scores across categories. Olive oil and wine recorded the highest scores (4.6 each), confirming their role as positively evaluated foundational elements. Bread recorded a comparatively low score of 4.2. This difference is exploratory rather than diagnostic; it suggests, but does not demonstrate, that bread-related formats and pairings may represent an underexplored design space for enhancing the gastronomic experience. As noted, the semantic heterogeneity of "bread" mentions cautions against over-interpretation. Consequently, this finding was used as a heuristic prompt–not a conclusive directive–to investigate bread-based vehicles for delivering the innovative spreads and creams developed in subsequent phases. The validity of this exploratory signal was assessed through expert evaluation and consumer testing.

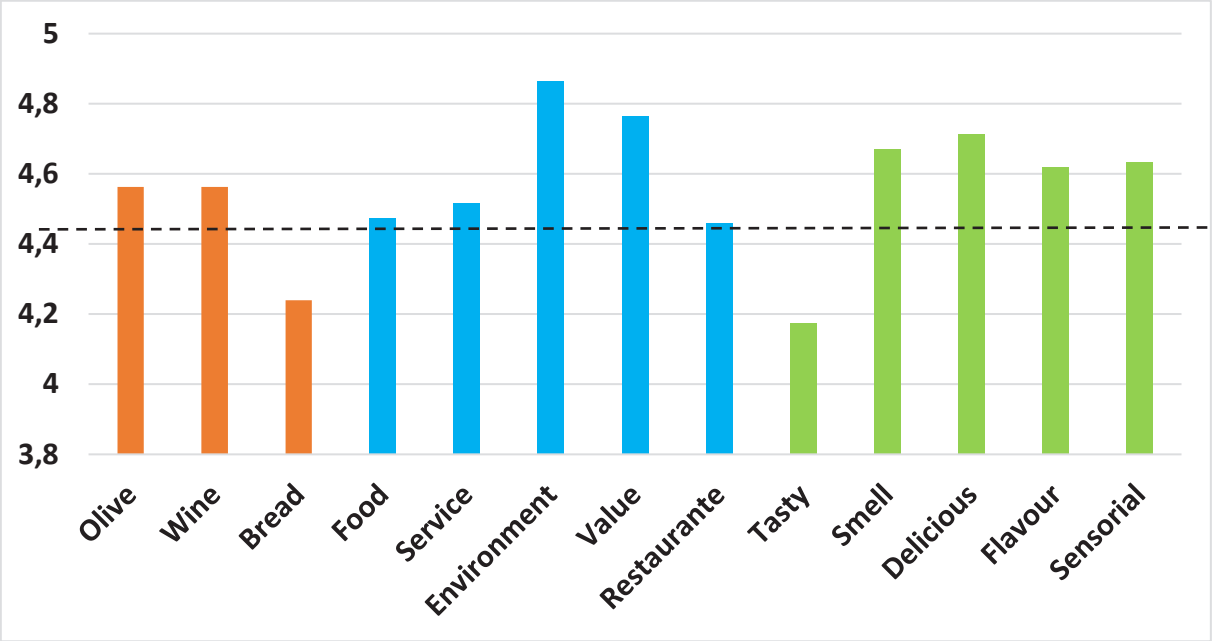


Figure 8. Comparison of the results of the sentiment analysis for each MD category

Mapping endogenous resources: A network approach to grounding innovation in territorial assets

The results show a Comprehensive Mapping of local resources and an Inventory of Local Producers. The inventory of Local Producers can be used to identify potential partners for developing new food products and promoting short marketing chains. The identification of Indigenous Species and Breeds should highlight the variety of indigenous species, breeds, and plant varieties (e.g., cattle, sheep, goats, various types of fish, dryland trees like almond and fig trees, citrus, vines, and others) present in the Algarve, showcasing the region's rich biodiversity.

Sensory tastings with experts

The sentiment analysis provided a consumer-driven foundation for the subsequent expert phase. Specifically, identifying bread as the product with the lowest sentiment score (4.2) and the highest innovation potential directly informed the decision to develop three alternative bread bases (corn, wheat, and carob) for the tasting experiments. Furthermore, the high sentimental value attributed to sensory attributes such as 'flavour' (4.6) and 'delicious' (4.7) guided the experts' focus on aromatic herbs (basil, thyme, oregano, pennyroyal) as key variables for enhancing the organoleptic profile of the innovative appetisers. Thus, the expert panel did not operate in a vacuum; rather, their evaluations were framed by the empirically derived consumer preferences. Six experts participated in a face-to-face tasting session, providing real-time feedback via an online questionnaire, which facilitated data collection and analysis, as illustrated in Figure 9.

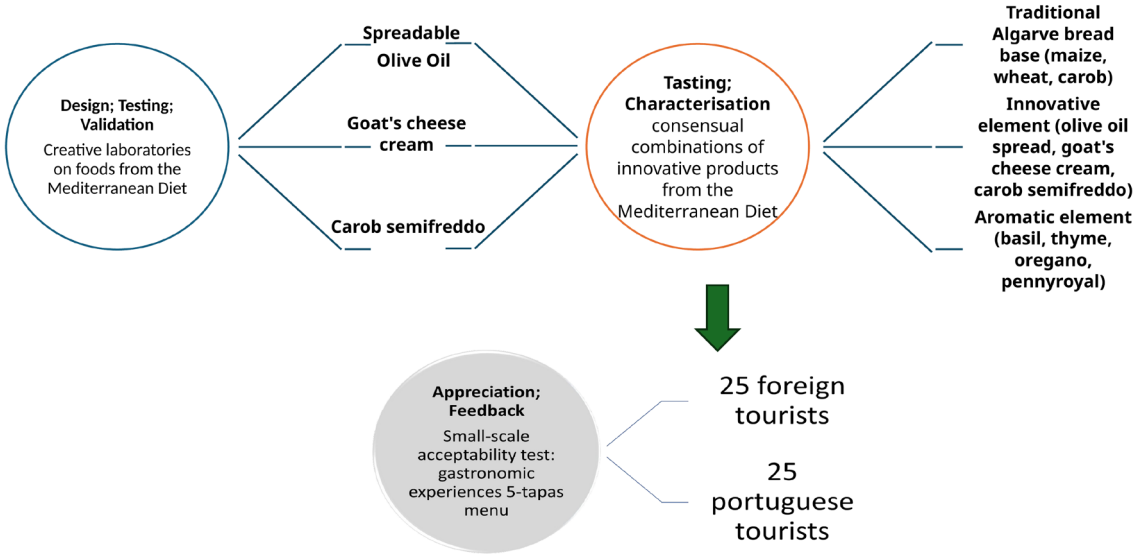


Figure 9. Innovative experiences with elements associated with the Mediterranean Diet

Each voting and consensus for each innovative element aimed at a first tasting of the innovative element, combined with corn, wheat and carob bread bases (except the carob semifreddo) and with four aromatic herbs previously selected as being typical of Mediterranean gastronomy, namely basil, thyme, oregano and pennyroyal, the results of which are presented in Table 3. The methodological approach followed the "group Delphi" principle.

Table 3. Table of "expert voting" results for each innovative element

Category	Traditional Algarve bread bases	Aromatic elements	Texture	Flavours	Taste/ Flavor	Average
Olive oil spread	Maize	Basil	5.60	5.80	6.20	5.87
		Thyme	5.60	6.00	5.20	5.60
		Oregano	5.60	5.80	5.00	5.47
		Pennyroyal	5.60	6.00	5.80	5.80
	Wheat	Basil	5.80	5.80	6.00	5.87
		Thyme	5.80	6.20	6.00	6.00
		Oregano	6.00	5.40	5.20	5.53
		Pennyroyal	5.80	6.60	6.00	**6.13**
	Carob	Basil	6.00	5.40	6.20	5.87
		Thyme	6.20	5.60	6.40	6.07
		Oregano	6.00	5.20	5.00	5.40
		Pennyroyal	6.00	6.60	5.80	**6.13**
Goat's cheese cream	Maize	Basil	6.80	6.00	6.20	6.33
		Thyme	6.20	6.40	6.20	6.27
		Oregano	6.60	6.20	6.00	6.27
		Pennyroyal	6.60	6.20	6.00	6.27
	Wheat	Basil	6.20	6.80	6.20	6.40
		Thyme	6.40	6.40	6.00	6.27
		Oregano	6.20	6.20	6.00	6.13
		Pennyroyal	6.20	6.00	6.20	6.13
	Carob	Basil	6.40	6.60	7.20	**6.73**
		Thyme	6.60	7.20	6.80	**6.87**

Category	Traditional Algarve bread bases	Aromatic elements	Texture	Flavours	Taste/ Flavor	Average
Carob semifreddo		Oregano	6.40	5.60	6.20	6.07
		Pennyroyal	6.40	6.40	6.20	6.33
		Basil	7.40	6.00	6.40	**6.60**
		Thyme	7.00	5.60	6.40	6.33
		Oregano	6.60	4.60	4.80	5.33
		Pennyroyal	7.40	5.80	5.40	6.20

Small-scale acceptability test to test and validate a gastronomic experience

For the final step, the two previous combinations with the most votes for each innovative element, combined with the bread base and aromatic herb elements, were implemented. The most-voted combination of the carob semifreddo and the aromatic herb element was also selected (Table 4). The results in Table 4 show that the combination most appreciated by the experts was goat cheese on a base of carob bread and flavored with thyme.

Table 4. Suggestions with the most votes from experts for each innovative element

Innovative element	Traditional Algarve bread bases	Aromatic elements	Attributes			
			Texture	Flavours	Taste / Flavor	Average
Olive oil spread	Wheat	Pennyroyal	5.80	6.60	6.00	**6.13**
	Carob	Pennyroyal	6.00	6.60	5.80	**6.33**
Goat's cheese cream	Carob	Thyme	6.60	7.20	6.80	**6.87**
	Carob	Basil	6.40	6.60	7.20	**6.73**
Carob semifreddo		Basil	7.40	6.00	6.40	**6.60**

Table 5. Average values and absolute preference (Experts)

Specialists (laboratory environment)			
Category	**Traditional Algarve bread bases**	**Aromatic elements**	**Average**
Olive oil spread	Wheat	Pennyroyal	**6.13**
	Carob	Pennyroyal	**6.33**
Goat's cheese cream	Carob	Thyme	**6.87**
	Carob	Basil	**6.73**
Carob semifreddo		Basil	**6.60**
			6.53

As a result of the previous activities, a gastronomic experience was developed that includes at least one of the developed ingredients (Table 6). This study aimed to investigate satisfaction and test the acceptability of the gastronomic experience while integrating innovative elements through a small-scale acceptability test.

Table 6. Suggestions of "appetisers" for a small-scale acceptability test

Innovative element	Traditional Algarve bread bases	Aromatic elements	Suggestions
Olive oil spread	Wheat	Pennyroyal	Olive oil spread with chopped fresh pennyroyal on a wheat bread "tiborna."
	Carob	Pennyroyal	Olive oil spread with chopped pennyroyal on carob bread.
Goat's cheese cream	Carob	Thyme	Goat's cheese cream and fresh lemon thyme chiffonnade on carob bread "tiborna."
	Carob	Basil	Goat's cheese cream with fresh basil chiffonade on carob bread "tiborna."
Carob semifreddo		Basil	Carob semifreddo on almond biscuit and basil syrup.

The acceptability test was completed by 25 Portuguese and 25 foreign customers, for a total of 50 respondents. 23 were male, and 27 were female. The age groups between 40 and 49 years old and the "over 60" group were the most influential. The foreign tourists are from Belgium, Brazil, the United Kingdom, France, Colombia, and China, and most have a higher education. The average values indicated an absolute preference of 6.13 on a hedonic scale of 1 to 9 by the public (Table 7).

The development of the three innovative food prototypes–spreadable olive oil, goat cheese cream, and carob semifreddo–was directly responsive to the insights yielded by the sentiment analysis. The high positive sentiment associated with olive oil (4.6) and wine (4.6) confirmed their suitability as foundational elements for innovation. Conversely, the comparatively lower sentiment for bread (4.2) signaled an opportunity to enhance the product, leading to the experimental manipulation of its texture and composition. Additionally, the strong sentimental response to the restaurant environment (4.9) and the emphasis on conviviality underscored the importance of creating products designed for sharing, which informed the decision to develop the final offerings in a 'tapa' (appetizer) format suitable for social dining experiences.

Table 7 - Average values and absolute preference (Public).

Public (catering environment)			
Category	**Types of clients**	**Average value**	**Average value General**
Olive oil spread with chopped fresh pennyroyal on a wheat bread "tiborna"	National	5.44	
			5.52
	Foreigners	**5.60**	
Olive oil spread with chopped pennyroyal on carob bread	National	5.04	
			5.18
	Foreigners	**5.32**	
Goat's cheese cream and fresh lemon thyme chiffonnade on carob bread "tiborna"	National	**6.52**	
			5.92
	Foreigners	5.32	
Goat's cheese cream with fresh basil chiffonade on carob bread "tiborna"	National	**7.12**	
			6.80
	Foreigners	6.48	
Carob semifreddo on almond biscuit and basil syrup	National	**7.28**	
			7.22
	Foreigners	7.16	
			6.13

DISCUSSION

The relationship between gastronomic innovation and regional development is not automatic; it operates through specific mechanisms that should be made explicit. First, innovation in gastronomic products and experiences contributes to the differentiation of the tourism offer, enabling regions such as the Algarve to position themselves in an increasingly competitive market through unique and authentic value propositions (Hjalager, 2022). Second, the valorization of endogenous products and the creation of new recipes using these ingredients foster the development of short supply chains, strengthening the connection between local producers, restaurants, and consumers, and retaining greater added value within the regional economy (Brinkley, 2018). Third, the enhancement of the consumer experience–reflected in sensory attributes such as taste, texture, and presentation–generates positive recommendations and repeat visits, amplifying economic impact through word-of-mouth marketing and reducing seasonality (Kovalenko et al., 2023). Finally, innovation anchored in intangible cultural heritage, such as the MD, reinforces the authenticity and identity of the destination, creating a virtuous cycle in which cultural preservation and economic development mutually reinforce one another (Stalmirska & Ali, 2023). Thus, sentiment analysis of individual gastronomic experiences–captured on platforms such as TripAdvisor–constitutes a first level of evidence that, when integrated with these mechanisms, enables an understanding of how tourist perceptions can influence sustainable regional development trajectories.

Sentiment analysis has emerged as a valuable methodological tool for understanding tourists' preferences, particularly in the context of gastronomic tourism. It facilitates the development of new, appealing food products that not only preserve cultural heritage but also align with the United Nations Sustainable Development Goals (SDGs). This approach suggests that innovation in traditional food practices can significantly enhance a region's tourism appeal while contributing to its long-term sustainability.

By analyzing sentiments related to a destination's cultural dimensions of gastronomy, researchers can gain insights into visitors' expectations for products and services. This understanding enables the identification of opportunities for

innovation in products and services that share similar characteristics, thereby contributing to the well-being of both local populations and tourists, as well as to the overall sustainability of the destination (Alcoba et al., 2020).

A growing body of empirical research focuses on tourists' online reviews and comments, reflecting an increasing trend toward digital engagement in booking and evaluating tourism-related services. These digital footprints reveal significant emotional responses and preferences, particularly in relation to the MD. Gastronomic innovation, often guided by consumer preferences and perceptions of quality, adds value and enhances the attractiveness of the tourism sector, as highlighted by Gonçalves et al. (2023).

In the case study exploring the gastronomic dimension of the MD, four thematic categories were analyzed through sentiment analysis of social media content. This analysis led to the development of a framework for evaluating gastronomic tourist experiences. The findings underscored the importance of key elements, including olive oil and wine, the restaurant environment, and the sensory dimensions of taste and aroma. The identification of bread as the component of the 'Mediterranean trilogy' with the lowest average sentiment score (4.2) provides an exploratory signal warranting further investigation. This study does not claim that this score demonstrates an 'innovation deficit' or directly mandates innovation of bread products. Rather, it serves as an exploratory signal–a heuristic prompt to investigate bread-based formats and pairings as potential vehicles for innovation. While this finding does not in itself demonstrate an 'innovation deficit', it aligns with the theoretical framework of Gonçalves et al. (2023) by suggesting that bread-related formats and pairings–rather than the bread product itself–may represent a design space for enhancing the gastronomic experience. This interpretation challenges the traditional view of bread as a mere symbol of frugality (Sánchez-Hernández, 2023) by repositioning it as a potential carrier and modulator of sensory innovation, particularly when combined with highly valued elements such as olive oil and wine. While Bernardes and Oliveira (2015) position bread as a foundation for culinary innovation, our results suggest that, in the tourist's perception, this potential is not being fully realized, possibly due to factors such as presentation, the lack of connection to a local narrative, or a sensory experience that falls short of the expectations created by other elements such as olive oil and wine. This disconnection between the product's symbolic value in literature and its perception by consumers reinforces the thesis of Kandampully et al. (2023) that innovation should be oriented towards creating new experiences rather than the product itself.

This outcome is particularly noteworthy, as Mehraliyev et al. (2022) note that few studies have evaluated restaurant food service quality through sentiment analysis of social media data. The framework developed in this study identified olive oil and wine as the products that elicited the most positive sentiments, while bread emerged as an area for improvement. High sentiment scores were also recorded for the overall dining environment, including taste and ambiance. The environment and the perceived value of restaurants were consistently rated highly by consumers.

The second phase of the study highlighted the Algarve region's rich biodiversity, showcasing a variety of indigenous species, breeds, and plant varieties. These include cattle, sheep, goats, fish, and trees such as almond, fig, citrus, and grapevine, as emphasized in the FAO Strategic Framework (FAO, 2022). The analysis also underscored the importance of linking these native resources with certified traditional products. The findings revealed considerable potential to enhance the value of traditional products by increasing certification, particularly for abundant, regionally authentic resources–an aspect widely recognized in the literature (Graça, 2014; UNESCO, 2024).

The third phase of the study emphasized the importance of expert recommendations and consumer satisfaction for the success of tourism-related businesses in the Algarve, particularly in the gastronomy sector. The results revealed a clear preference for specific combinations, with goat cheese on carob bread flavored with thyme being the most appreciated. In contrast, olive oil spread on wheat bread with pennyroyal was the least favoured. The overall average preference score of 6.53 on a 9-point hedonic scale indicated a generally positive reception of the tested combinations, although there remains room for refinement.

In the fourth phase, the results (Table 7) indicated that the carob and basil semifreddo was the most appreciated combination among the public. Conversely, the olive oil spread on carob bread with pennyroyal received the lowest ratings. This pattern of preference was consistent across both national and international tourists.

A small-scale acceptability test (Table 7) was conducted to validate the gastronomic experience, following the methodological recommendations of Alvelos (2002). The products were generally well-received by both experts and tourists. Although the sample size was limited to 50 participants, thus restricting the generalizability of the findings, there was a high degree of consensus between Portuguese and foreign respondents, as well as between the broader participant group (Phase 4) and the Delphi panel of experts (Phase 3). The carob and basil semifreddo was again identified as the most

appreciated combination, while the olive oil spread on carob bread with pennyroyal was confirmed as the least favored, indicating a clear direction for future product refinement.

Examination of the rank order of preferences reveals agreement between the expert panel and the public on the most preferred item (carob semifreddo with basil) and the least preferred item (olive oil spread on carob bread with pennyroyal). However, notable differences were observed between Portuguese and foreign respondents for specific items–for example, goat cheese cream with lemon thyme scored more than one hedonic unit higher among national participants (6.52) than among international tourists (5.32)–indicating that while broad patterns of acceptance may converge, cultural or familiarity factors may modulate the intensity of preference for certain combinations. Given the limited number of menu items (n=5), we refrain from reporting a correlation coefficient, as such a statistic would be underpowered and potentially misleading. Instead, we present these findings descriptively, noting consistency in the top and bottom rankings while acknowledging variability in intermediate preferences.

The varying levels of tourist engagement with gastronomy contribute to the development and refinement of memorable culinary experiences. This research highlights the strategic importance of gastronomy in positioning the Algarve as a competitive tourist destination in both national and international markets. The innovative products developed through this study have both theoretical and practical implications.

Hospitality and tourism enterprises stand to benefit from recognizing the value of local food systems and the potential of gastronomic innovation grounded in authentic regional products. The findings also offer valuable insights for destination marketers, who are increasingly aware that tourists seek unique and meaningful experiences. As Stalmirska and Ali (2023, p. 8) suggest, food can serve as "a powerful medium in supporting socio-cultural identity by building local connectivity and enabling inclusivity, positively impacting the destination in the long run."

The central research question–How can consumer insights, derived from sentiment analysis, guide the innovation of appetizers based on the MD to enhance the gastronomic tourism offer in Tavira, Algarve? –is addressed by proposing a framework that integrates traditional culinary practices with contemporary innovation to create sustainable, authentic, and appealing gastronomic experiences in the Algarve. The study provides exploratory evidence that understanding and responding to tourist preferences through sentiment analysis, while leveraging local resources, may enhance the region's appeal as a sustainable tourism destination. Confirmation of this effect requires further research with direct sustainability metrics. This approach not only preserves cultural heritage but also supports economic development through innovative gastronomy, aligning with the principles of the MD and global sustainability objectives.

The study's methodological coherence is supported by triangulation of the results. The sentiment analysis, by identifying the sensory dimension ('flavour' and 'delicious') as highly valued (Figure 7), provided the framework for the structured evaluation by the experts, who focused on the attributes 'texture,' 'flavours,' and 'taste/aroma' (Table 3). This approach operationalizes the recommendations of Fiorentini et al. (2020) and Moreno-Lobato et al. (2024) regarding the cultural relevance of sensory elements in tourist satisfaction. Furthermore, the partial concordance between the preferences of the experts and the public, particularly in the appreciation of the 'carob semifreddo with basil,' not only replicates the findings of Cardello and Maller (1982) on the reliability of panels, but also demonstrates that the digitally captured 'voice of the customer' (Rita et al., 2023) can be a reliable guide for innovation co-created with experts. Furthermore, the alignment between expert preferences and public responses–both groups identified the carob and basil semifreddo as highly appreciated–validates the expert selection process and reinforces the reliability of the sentiment analysis as a diagnostic tool. This triangulation of methods demonstrates that consumer insights, expert knowledge, and experimental development are not discrete phases but mutually reinforcing elements of a unified innovation framework.

The findings of this study must be interpreted within the context of a specific methodological limitation in the sentiment analysis protocol. While the VADER study employed manual validation ($\kappa = 0.84$; 87.5% agreement with human coders), the approach does not incorporate aspect-based sentiment analysis (ABSA), which would enable fine-grained sentiment attribution to specific product attributes (e.g., bread freshness vs bread portion size vs bread accompaniments). The keyword-matching strategy, while transparent, may misattribute sentiment when target words appear in negated or complex syntactic constructions, despite VADER's built-in negation handling. Furthermore, the exclusive use of English-language reviews may introduce linguistic and cultural bias; non-English-speaking tourists may have different sensory expectations and evaluative criteria. The collection of data, while recorded, does not permit analysis of sentiment trends over time, which could reveal seasonal or year-on-year variations in tourist perceptions. Future research should address these limitations by: (i) implementing ABSA to disambiguate heterogeneous product references; (ii) expanding

to multiple languages using validated multilingual sentiment models; and (iii) adopting longitudinal designs to track sentiment dynamics.

The sentiment analysis, though revealing, was confined to English-language reviews on TripAdvisor, potentially excluding the perspectives of non-English-speaking tourists and those using alternative platforms, which may introduce linguistic and cultural bias. Furthermore, the small-scale acceptability test (n=50), while valuable for exploratory insights, limits the generalisability of the findings to the broader tourist population. The Delphi-based focus group, despite providing expert consensus, involved only six specialists, and the absence of full anonymity may have influenced individual responses. Notwithstanding these limitations, the study makes several theoretical contributions. First, it addresses the identified gap in the literature by demonstrating how sentiment analysis can operationalize consumer preferences to guide gastronomic innovation within the MD framework, responding directly to Mehraliyev et al.'s (2022) call for greater application of digital methods in hospitality research. Second, the study draws methodologically on network visualization techniques (Ahn et al., 2011) as a descriptive tool to support ingredient selection, without claiming theoretical extension. Third, the study contributes to the emerging discourse on sustainable gastronomic tourism by providing an empirically grounded model that integrates intangible cultural heritage (the MD) with tangible innovation outcomes, thereby operationalizing the theoretical propositions of Stalmirska and Ali (2023) regarding food as a medium for socio-cultural identity and sustainable development. The convergence of findings across methods–sentiment analysis, expert evaluation, and consumer testing–suggests that triangulated approaches can yield robust insights for destination management. However, the partial divergence between expert preferences (goat cheese with thyme) and public preferences (goat cheese with basil) underscores the need to validate expert-driven innovation through real consumer testing, highlighting a potential limitation of relying exclusively on expert panels. Future research should address these limitations by expanding the linguistic scope of sentiment analysis, increasing sample sizes for consumer testing, and exploring whether the observed preference patterns hold across different Mediterranean destinations and tourist demographics.

The high sentiment score for restaurant environment (4.9) underscores the importance of investing in the experiential and convivial dimensions of dining, not merely in food quality, suggesting that restaurateurs should consider the holistic experience–ambiance, service, and social interaction–as integral to tourist satisfaction

CONCLUSION

The study highlights the innovative potential of leveraging the MD to promote sustainable gastronomic tourism in the Algarve. Given the relevance of sentiment analysis and the richness of local products in terms of variety and quality, three innovative culinary recipes were developed in a university food engineering laboratory using local ingredients. These products were tested by experts, whose contributions led to significant improvements. As a result, 50 national and foreign participants tasted five appetizers in a real restaurant environment. The positive results indicate potential for application in various restaurant menu concepts.

The findings of this study directly address the research objective of understanding how consumer insights derived from sentiment analysis can guide the innovation of appetizers based on the MD to enhance the gastronomic tourism offer in Tavira, Algarve. By identifying bread as the component of the 'Mediterranean trilogy' with the lowest sentiment score (4.2), the study empirically validates the theoretical proposition of Gonçalves et al. (2023) regarding the need for product-centric innovation, while simultaneously challenging the traditional view of bread as a mere symbol of frugality (Sánchez-Hernández, 2023). Furthermore, the partial concordance between expert and consumer preferences for the carob and basil semifreddo not only reinforces the methodological principle established by Cardello and Maller (1982)–that laboratory-based preferences reliably predict field preferences–but also demonstrates that the digitally captured 'voice of the customer' (Rita et al., 2023) can serve as a reliable guide for innovation co-created with experts. The integration of sentiment analysis with endogenous resource mapping (Costa & Rosa, 2020a, 2020b) and expert validation operationalizes the multi-dimensional innovation framework proposed by Hjalager (2010), demonstrating that gastronomic innovation within the MD context can simultaneously encompass product, process, experiential, and marketing dimensions. Thus, the study contributes to the emerging discourse on sustainable gastronomic tourism by providing an empirically grounded, exploratory model that translates intangible cultural heritage into consumer-approved culinary prototypes. The model should be viewed as a proof-of-concept requiring further validation before claims of replicability or external validity can be made.

By combining traditional culinary practices with modern innovations, the study identifies opportunities to enhance tourist experiences and regional economic sustainability. A key finding is the need for further studies and research on innovation and knowledge transfer in the food and tourism industries, particularly in relation to the Mediterranean Diet in the Algarve.

This study, while offering valuable insights, is subject to several limitations that should be acknowledged when interpreting its findings. First, the sentiment analysis was confined to English-language reviews on TripAdvisor, potentially excluding the perspectives of non-English-speaking tourists and those using alternative platforms, which may introduce linguistic and cultural bias (Mehraliyev et al., 2022). Second, the small-scale acceptability test (n=50), although sufficient for exploratory validation, limits the generalisability of the findings to the broader tourist population; future research should expand sample sizes and include diverse demographic groups to enhance external validity. Third, the Delphi-based focus group, while providing expert consensus, involved only six specialists, and the absence of full anonymity in the 'group Delphi' format may have influenced individual responses (Van Zolingen & Klaassen, 2003). Fourth, the study focused exclusively on the municipality of Tavira; while this case-study approach allowed for in-depth analysis, it limits the transferability of the findings to other Mediterranean destinations with different endogenous resources and tourist profiles. Finally, the temporal scope of the research captures consumer preferences at a single point in time, not accounting for their dynamic evolution (Cliff et al., 2016).

A further limitation concerns the interpretation of the sentiment score for bread. Mentions of 'bread' on TripAdvisor are likely to be semantically heterogeneous, encompassing references to bread as a starter, as an accompaniment, as a textural element, or even in the context of dietary restrictions (e.g., gluten intolerance). Consequently, the aggregated sentiment score of 4.2 should be interpreted with caution, as it may not reflect a unified consumer perception of bread qua product. Future research could address this by employing more fine-grained aspect-based sentiment analysis or by complementing digital data with targeted consumer surveys that probe specific dimensions of the bread experience.

Future research should prioritize digital sentiment analysis to identify areas for gastronomic innovation and understand consumer preferences, thereby enhancing the innovation and value of regional gastronomy. The second step highlighted the potential to create a detailed inventory of local producers and suppliers in the Algarve, aiding in the identification of potential partners for new food product development and promoting short marketing chains. The third step should focus on: (i) Consumer Testing and Market Validation, exploring consumer responses to snack combinations and assessing their market potential across different demographic groups; (ii) Exploration of New Combinations, investigating innovative combinations of local ingredients; (iii) Impact of Presentation and Context, examining the role of presentation and dining context in consumer satisfaction; (iv) Longitudinal Studies on Taste Preferences, understanding their evolution over time; and (v) Sustainability and Local Sourcing, investigating the sustainability of ingredients used in preferred combinations, focusing on local sourcing and environmental impact. Future research in step four should focus on: (i) Broader Consumer Testing, expanding the acceptability test to a larger, more diverse audience, including different cultural backgrounds, age groups, and educational levels, to better understand the gastronomic experience's appeal; (ii) Refinement of the Tasting Menu, refining the menu based on initial feedback; (iii) Cultural and Regional Preferences, investigating how cultural and regional differences influence the acceptability of innovative gastronomic elements, helping tailor the menu to different tourist demographics; (iv) Long-Term Impact on Tourism, focusing on how innovative food offerings can enhance the region's attractiveness as a culinary destination; and (v) Sustainability and Ingredient Sourcing, assessing the sustainability of the ingredients used in the tasting menu and exploring ways to promote sustainable gastronomy practices.

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Author contribution statement

Célia M.Q Ramos: Conceptualization, Data Curation, Formal Analysis, Methodology, Writing – Original Draft Preparation, Supervision, Writing – Review & Editing. **Manuel Serra**: Conceptualization, Data Curation, Writing – Original Draft Preparation, Resources, Writing – Review & Editing. **Alexandra R. Gonçalves**: Conceptualization, Data Curation, Investigation, Methodology, Project Administration, Visualization, Writing – Review & Editing.

Declaration

We declare that we use an AI tool for English translation and revision.
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