ENGENHARIAS, TECNOLOGIA, GESTÃO E TURISMO
ENGINEERING, TECHNOLOGY, MANAGEMENT AND TOURISM
INGENIERÍA, TECNOLOGÍA, ADMINISTRACIÓN Y TURISMO

millenium

Millenium, 2(Edição Especial Nº19)

en

PROPOSTA PARA A VALORIZAÇÃO DE RESÍDUOS DA PRODUÇÃO DE VINHO ESPUMANTE NO TURISMO ENOGASTRONÓMICO

PROPOSAL FOR UPCYCLING SPARKLING WINEMAKING WASTE FOR OENOGASTRONOMY TOURISM

PROPUESTA PARA LA REVALORIZACIÓN DE RESIDUOS DE LA PRODUCCIÓN DE VINO ESPUMOSO EN EL TURISMO ENOGASTRONÓMICO

Catarina Flores[1,2,3] *https://orcid.org/0009-0003-1739-7753*
Tamara Ribeiro[1] *https://orcid.org/0009-0000-5766-5204*
João Santos[4,5] *https://orcid.org/0000-0003-3775-1222*
Catarina Prista[2,6] *https://orcid.org/0000-0001-9307-1905*
Goreti Botelho[1,7] *https://orcid.org/0000-0003-3857-3544*

[1] Instituto Politécnico de Coimbra, Coimbra, Portugal
[2] Universidade de Lisboa, Escola Superior de Agronomia (ISA), Lisboa, Portugal
[3] Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Lisboa, Portugal
[4] Universidade de Coimbra, Coimbra, Portugal
[5] ADAI - Associação para o Desenvolvimento da Aerodinâmica Industrial, Coimbra, Portugal
[6] Centro de Investigação em Agronomia, Alimentos, Ambiente e Paisagem, Lisboa, Portugal
[7] Centro de Investigação de Recursos Naturais, Ambiente e Sociedade (CERNAS), Coimbra, Portugal

Catarina Flores -catarinaffonseca@outlook.com |Tamara Ribeiro - tamaracribeiro@gmail.com |João Santos - jrfs@uc.pt |
Catarina Prista - cprista@isa.ulisboa.pt |Goreti Botelho - goreti@esac.pt

Corresponding Author:
Goreti Botelho
Rua da Misericórdia, Lagar dos Cortiços
3045-093 -Coimbra - Portugal
goreti@esac.pt

RECEIVED: 01st April, 2025
REVIEWED: 18th April,2025
ACCEPTED: 24th April, 2025
PUBLISHED: 02nd June, 2025

DOI: https://doi.org/10.29352/mill0219e.41097

RESUMO

Introdução: O turismo enogastronómico tem vindo a focar-se cada vez mais na economia circular e na sustentabilidade. Após a segunda fermentação alcoólica em garrafa, as leveduras encapsuladas em esferas de alginato de cálcio usadas na produção do vinho espumante perdem viabilidade e são descartadas pelas adegas.
Objetivo: Este trabalho explorou o potencial do Canvas do Modelo de Negócio em Três Camadas (CMNTC) como suporte para desenvolver soluções, focadas em inovações gastronómicas, como vinagretes, para reciclar e valorizar resíduos da produção de vinho espumante.
Métodos: A metodologia do MNCTC foi utilizada para criar uma proposta de modelo baseada nos pilares económico, ambiental e social. Foram desenvolvidos quatro vinagretes em escala laboratorial com perfis de sabor distintos, todas com 3,5% m/m de esferas de alginato de cálcio: hortelã (V-Ar), algas (V-Água), picante (V-Fogo) e cogumelos (V-Terra). Além disso, foi avaliada a intenção de compra dos vinagretes, por um grupo de 40 consumidores.
Resultados: A integração dos princípios da economia circular na inovação gastronómica foi analisada através de aspetos-chave do MNCTC, incluindo proposta de valor, atividades-chave, recursos, parcerias e relações com clientes. A análise da intenção de compra das quatro formulações de vinagretes revelou que a formulação V-Terra obteve os melhores resultados positivos (36% provavelmente comprariam, 44% comprariam certamente), seguida da V-Fogo (35% e 30%).
Conclusão: A adoção de uma abordagem de economia circular através da reciclagem de resíduos da indústria do vinho espumante pode levar ao desenvolvimento de produtos e serviços gastronómicos inovadores, direcionados a turistas enogastronómicos que valorizam a sustentabilidade, a economia circular e a inovação gastronómica.

Palavras-chave: resíduos de vinho espumante; economia circular; turismo enogastronómico; inovação gastronómica

ABSTRACT

Introduction: Oenogastronomic tourism is increasingly focusing on the circular economy and sustainability. After the second alcoholic fermentation in the bottle, the yeast encapsulated in calcium alginate beads used in sparkling wine production loses viability and is discarded by the wineries.
Objective: This work explored the potential of the Triple Layer Business Model Canvas (TLBMC) as a support to develop solutions, focused on gastronomic innovations, such as vinaigrettes, to recycle and valorise sparkling wine production waste.
Methods: The methodology of TLBMC was used to create a proposal for a model regarding the economic, environmental and social perspectives. Four vinaigrettes were developed on a laboratory scale in distinct flavour profiles, all of them with 3.5% w/w calcium alginate beads: mint (V-Air), algae (V-Water), spicy (V-Fire) and mushroom (V-Earth). Moreover, purchase intention with a group of 40 consumers was assessed.
Results: The integration of circular economy principles within gastronomic innovation was examined through key aspects of the TLBMC, including value proposition, key activities, resources, partnerships and customer relations. The purchase intention analysis of four vinaigrette formulations revealed that V-Earth had the highest positive results (36% probably buy, 44% certainly buy), followed by V-Fire (35% and 30%).
Conclusion: Adopting a circular economy approach by recycling waste from the sparkling wine industry could lead to innovative gastronomic products and services aimed at oenogastronomic tourists who value sustainability, the circular economy and culinary innovation.

Keywords: sparkling wine waste; circular economy; oenogastronomic tourism; gastronomy innovation

RESUMEN

Introducción: El turismo enogastronómico se ha centrado cada vez más en la economía circular y la sostenibilidad. Después de la segunda fermentación alcohólica en botella, las levaduras encapsuladas en esferas de alginato de calcio utilizadas en la producción de vino espumoso pierden viabilidad y son descartadas por las bodegas.
Objetivo: Este estudio exploró el potencial del Canvas Modelo de Negocio en Tres Capas (MNCTC) como un apoyo para desarrollar soluciones, enfocadas en innovaciones gastronómicas, como vinagretas, para reciclar y valorizar los residuos de la producción de vino espumoso.
Métodos: Se utilizó la metodología del MNCTC para crear una propuesta de modelo basada en los pilares económico, ambiental y social. Se desarrollaron cuatro vinagretas a escala de laboratorio con perfiles de sabor distintos, todas con un 3,5% m/m de esferas de alginato de calcio: menta (V-Aire), algas (V-Agua), picante (V-Fuego) y hongos (V-Tierra). Además, se evaluó la intención de compra en un grupo de 40 consumidores.
Resultados: La integración de los principios de la economía circular en la innovación gastronómica se analizó a través de aspectos clave del MNCTC, incluyendo propuesta de valor, actividades clave, recursos, asociaciones y relaciones con los clientes. El análisis de la intención de compra de las cuatro formulaciones de vinagretas reveló que la formulación V-Tierra obtuvo los mejores resultados positivos (36% probablemente la comprarían, 44% la comprarían con certeza), seguida de la V-Fuego (35% y 30%).
Conclusión: La adopción de un enfoque de economía circular a través del reciclaje de residuos de la industria del espumoso puede llevar al desarrollo de productos y servicios gastronómicos innovadores, dirigidos a turistas enogastronómicos que valoran la sostenibilidad, la economía circular y la innovación gastronómica.

Palabras Clave: residuos de vino espumoso; economía circular; turismo enogastronómico; innovación gastronómica

DOI: https://doi.org/10.29352/mill0219e.41097

INTRODUCTION

In recent years, gastronomic tourism has become a dynamic field for exploring innovative responses to sustainability challenges, particularly at the intersection of food culture, tourism and environmental responsibility. Innovation and creativity are increasingly recognised as strategic elements in gastronomic tourism, contributing to destination development, value creation and cultural enrichment (Kuhn et al., 2024). This reflects a growing recognition of food as a key tourism asset and research focus within hospitality studies (Okumus et al., 2018). Besides, the growing global concern for environmental sustainability has led to the rise of circular economy models, which prioritise waste reduction, resource efficiency and sustainable production. Gastronomic tourism, particularly in the wine sector, can greatly benefit from adopting circular economy principles (Alessandroni et al., 2024). The evolution of gastronomy, driven by a constant quest for creativity and adaptation to emerging trends such as sustainability and the circular economy, has led to a greater emphasis on maximising the value of food by-products (Alessandroni et al., 2024). In this context, collaboration between chefs, academia and entrepreneurs has been essential in optimising the use of underutilised ingredients and convincing the population to adhere to this trend, transforming them into new, high-value resources or products (Højlund & Mouritsen, 2025). Through gastronomic valorisation, it is possible to minimise food waste and contribute to environmental sustainability, economic growth and cultural innovation within the food sector. Although this approach may seem modern, it revives traditional practices of domestic economy, adapting them to the current challenges of overproduction, excessive consumption and their associated environmental impact (Alessandroni et al., 2024; Højlund & Mouritsen, 2025). Moreover, the connection between local food and sustainability is often mediated by innovation, which reinforces the essential role that creative strategies play in making the food sector more sustainable (Moura et al., 2024).

Bairrada (including "Bairrada" Protected Designation of Origin and "Beira Atlântico" Protected Geographical Indication), in Portugal, is the country's largest sparkling wine-producing region (Instituto da Vinha e do Vinho, 2024). It is situated between Águeda and Coimbra, delimitated at North by the Vouga River, South by the Mondego River, East by the Caramulo and Buçaco mountains and at Oest by the Atlantic Ocean. It is a predominantly flat region, where vineyards rarely exceed 120 meters in altitude and due to its level terrain and proximity to the ocean, it experiences a mild climate strongly influenced by maritime conditions (Instituto da Vinha e do Vinho, 2023). Besides, the Bairrada region has both large wine companies (with distinct oenotourism services), some of which operate in different wine regions across the country and wine tourism hotspots, such as family-owned small enterprises, which are renowned for offering a unique and enjoyable wine tourism experience, thus becoming sought-after destinations for travellers interested in wine (Santos et al., 2025). In such rural regions, gastronomic tourism has the potential to boost local development, provided it is well managed through governance models that align the needs of both tourists and local communities (Moura et al., 2024).

The use of yeasts encapsulated in calcium alginate beads during the second fermentation of sparkling wine aids in the remuage process. After disgorgement, the yeast cells lose cellular viability (Ribeiro, 2024, p. 37) and for this reason, the alginate beads are discarded. During the 2023/24 production cycle, at least 37,460 hL of sparkling wine were produced in the Bairrada region (Instituto da Vinha e do Vinho, 2024). Some of these wines employ calcium alginate beads in their production, generating waste that remains unexplored in wineries but holds innovative gastronomic potential. Widely used in molecular gastronomy, calcium alginate stands out for its edibility and potential value for culinary innovations (Moreno-García et al., 2018). On average, the production of 770 bottles (750 mL each) of sparkling wine generates 1 kg of alginate bead waste (Ribeiro, 2024). This study proposes a solution to this issue (Figure 1).

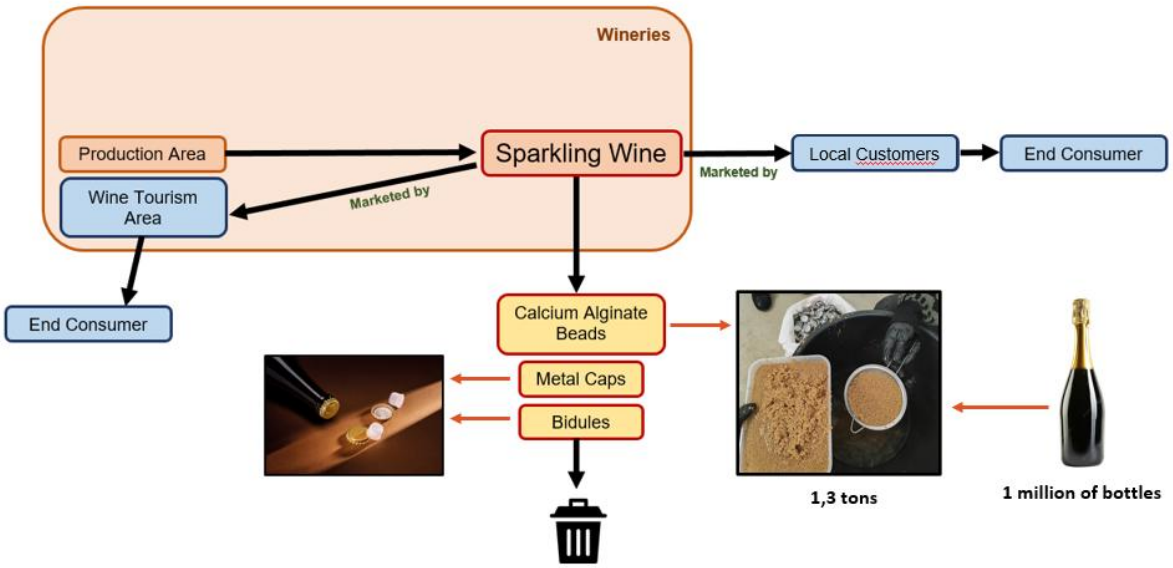

Figure 1 – Schematic representation of calcium alginate beads waste from sparkling wine production.

DOI: https://doi.org/10.29352/mill0219e.41097

The specificity of food and wine can connect consumers to a geographic area (Mikinac et al., 2022). Moreover, local gastronomy is often associated with wines, strengthening the identity of that specific region. This oenogastronomy plays an important role in the development of wine tourism (Jantsch et al., 2024).
The Triple Layered Business Model Canvas (TLBMC) framework applied to oenogastronomic projects ensures a holistic approach to business planning, considering economic, social and environmental sustainability (Joyce & Paquin, 2016).
The main objective of this work was to show the potential of the TLBMC as a support to develop solutions for oenogastronomic tourism, focused on gastronomic innovations, such as vinaigrettes with calcium alginate beads, to reuse and valorise sparkling wine production waste.

2. METHODS

The development of our solution was structured using the TLBMC, which provided a comprehensive framework for analysing the economic, environmental and social dimensions of the proposal. This approach ensured that the conceptualisation of the model aligned with circular economy principles while fostering local economic development and gastronomic innovation.

2.1 Conceptual framework

Drawing upon the literature reviewed, the conceptual framework was built around five main pillars: circular economy, innovation in food products, regional cooperation, oenogastronomic tourism and financial resilience. These guiding principles shaped the system's design, ensuring alignment with sustainable development goals and facilitating stakeholder participation.
The methodology incorporates circular economy thinking by proposing the transformation of waste generated during the secondary fermentation of sparkling wine into culinary resources. The innovation component explores new gastronomic uses for calcium alginate beads, with input from a multidisciplinary team. Local engagement is encouraged through collaboration among wineries, producers and other actors within a cohesive network.
Additionally, the model considers the integration of food-related experiences into wine tourism strategies. Economic sustainability is also addressed through a multi-source revenue model designed to support long-term implementation and efficient resource use.

2.2 Triple Layered Model Canvas (TLBMC)

The TLBMC provides a structured approach to conceptualising the proposed model, integrating economic, environmental and social dimensions to ensure a holistic and sustainable framework (Joyce & Paquin, 2016).
The economic layer of the model establishes the fundamental components required to maintain the initiative's viability from a business standpoint. This involves determining income sources, cost structures, strategic partnerships and distribution networks, ensuring the model remains financially sustainable while upholding environmental and social responsibility.
The environmental layer examines how resources circulate within the system, evaluating the potential for reutilising calcium alginate beads. This approach helps minimise waste, optimise resource efficiency and reinforce circular economy principles, ensuring the initiative contributes positively to sustainability in the winemaking and gastronomy sectors.
The social layer considers the broader influence of the model on stakeholders, regional communities and consumer behaviour. It explores how the initiative encourages cooperation among wineries, food producers and distributors, fostering regional economic growth. Additionally, it highlights the role of consumer awareness and participation, particularly through gastronomic experiences that emphasise sustainable food consumption. By incorporating knowledge-sharing and capacity-building, the model aims to generate long-term social benefits that extend beyond its immediate economic and environmental impact.
By integrating these three dimensions, the TLBMC ensures the model is financially viable and environmentally responsible while generating a positive social impact. The Results section will provide a detailed breakdown of these interactions, demonstrating the practical implementation of this approach in the Bairrada wine region.

2.3 Purchase intention assessment

Data protection measures were implemented for this study to ensure compliance with legal regulations. The research received prior approval from the Ethics Committee of the Polytechnic University of Coimbra (approval reference: D36/2024) on 25th September 2024 and was conducted under the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants involved in the purchase intention assessment.
Four vinaigrettes were developed on a laboratory scale in distinct flavour profiles inspired in the four elements (Habashi, 2000), all of them with 3.5% (w/w) calcium alginate beads: mint (V-Air), algae (V-Water), spicy (V-Fire) and mushroom (V-Earth). Purchase intention with a group of 40 potential consumers was assessed.The samples were evaluated based on the principles and methodologies outlined in ISO 11136:2014.
The four samples were assigned random codes before being presented to the participants, who were unaware of the type or formulation of the vinaigrettes.

DOI: https://doi.org/10.29352/mill0219e.41097

For the purchase intention assessment, tasters were asked to rate each sample on a scale from 1 to 5. A score of 1 indicated that the taster "would certainly not buy the product," while a score of 2 meant they "probably would not buy the product." A neutral score of 3 indicated uncertainty, with the taster "having doubts about whether they would buy the product." Higher scores represented a more positive purchase intention, with 4 indicating that the taster "would probably buy the product" and the highest score of 5 signifying that the taster "would certainly buy the product."

3. RESULTS

The proposed model was developed to address the discarding of calcium alginate beads used in the secondary fermentation of sparkling wine, as represented in Figure 2, offering a sustainable and economically viable alternative that integrates circular economy principles with oenogastronomic tourism. By establishing a structured system that fosters collaboration between wineries, local food producers, distributors and consumers, the initiative seeks to repurpose this waste into innovative gastronomic applications, reducing waste while generating new economic opportunities within the region's food and wine sector.

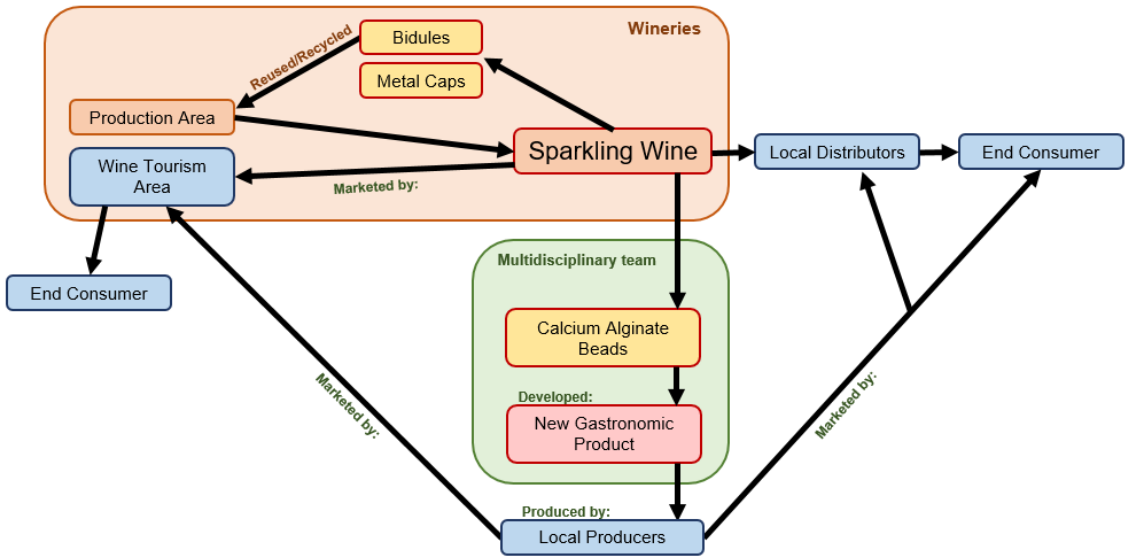

Figure 2 – Schematic representation of the proposed model to valorise calcium alginate beads.

At the core of the model is a central consultancy entity responsible for facilitating product development and market integration rather than directly producing or commercialising the products. This entity coordinates the collection of calcium alginate beads from participating wineries, ensuring their proper storage and quality control and delivering them to local producers and food companies interested in incorporating them into their product lines.

A key function of the multidisciplinary team within the consultancy entity is to support local producers and businesses in the development of new food products. This team, composed of experts in oenogastronomy, food science and sustainability, does not manufacture products. Instead, it provides technical guidance, recipe formulation assistance and standardisation support to ensure that the products developed by local producers are market-ready and commercially viable. By leveraging this expertise, the initiative enables small-scale producers and food businesses to introduce new, high-value gastronomic offerings while maintaining control over their production processes.

The commercialisation of these products is designed to be fully integrated into existing distribution networks, with local producers and partner companies taking charge of the manufacturing and sales. The developed products can be marketed directly through wineries as part of wine tourism experiences, sold in local gourmet shops and distribution outlets and supplied to restaurants and other retailers, expanding their reach and consumer engagement. Therefore, the target audience is oenogastronomic tourists, eco-conscious consumers and gourmet product consumers.

Beyond product development, the consultancy entity plays a crucial role in promoting and positioning these new products within the market. This result is achieved through gastronomic events that involve tastings, workshops and showcookings, which not only showcase the innovative use of calcium alginate beads but also educate consumers on sustainable food practices and regional identity. These events create a direct link between producers, distributors and end consumers, enhancing the visibility and desirability of the newly developed products while reinforcing Bairrada's reputation as a hub for sustainable and innovative gastronomy. In Figure 3, the results of the purchase intention assessment are presented.

DOI: https://doi.org/10.29352/mill0219e.41097

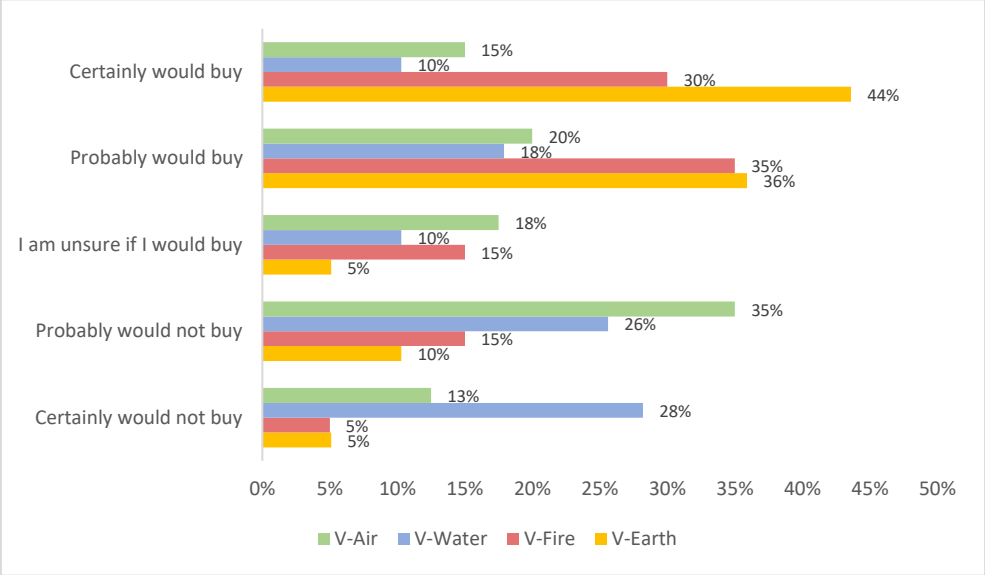

Figure 3 – Purchase intention of the four vinaigrettes.

4. DISCUSSION

Gastronomic tourism fosters connections between visitors, local communities and traditions and is increasingly recognised as a key driver of local economic development and of services that support the tourism ecosystem, such as food, accommodation, retail and cultural activities (Kim et al., 2009). Its inherently multi-faceted nature allows it to enrich the overall visitor experience by combining sensory, cultural and social elements (Okumus et al., 2018; Tsai & Wang, 2017). Consequently, the industry has undergone rapid evolution in recent decades, with innovative forms of experiential food tourism emerging at an increasing pace (Robinson et al., 2018).

Food tourism also provides an opportunity to promote sustainable diets and circular practices by encouraging the exploration of local food cultures and the valorisation of regional products and activities. Moreover, it benefits the economy and the environment but faces challenges from new technologies and consumer preferences (Naderi et al., 2024).

The Triple Layered Business Model Canvas (TLBMC) is a valuable strategic tool for designing sustainable and circular gastronomic models. Its holistic approach allows businesses to visualise the entire ecosystem—from sourcing to waste management—facilitating the integration of sustainability principles such as resource efficiency, upcycling and zero-waste strategies into the value proposition (Hastjarjo, 2024).

4.1 Viability and practical feasibility of the model

Following the completion of the TLBMC, it became evident that the feasibility of the proposed model relies on a robust collaborative structure centred on a consultancy entity responsible for coordinating the collection, storage and redistribution of calcium alginate beads. This collection process is relatively easy to implement, as the separation of the beads and bottle caps is already part of the standard sparkling wine production process.

The consultancy team does not act as a producer but rather as a facilitator of product development and market integration. The presence of a multidisciplinary team with expertise in gastronomy, food science and sustainability ensure the necessary technical support for local producers, making the model feasible without requiring significant investment in infrastructure on their part. Moreover, the use of existing infrastructure among partners, combined with an already established distribution network, further enhances the model's practical applicability.

4.2 Financial sustainability

This initiative presents notable economic potential by contributing to the reduction of waste-related expenses for wineries while also enabling the creation of new market opportunities through the development and promotion of innovative gastronomic products. The proximity between local food systems and sustainability is often mediated by innovation, which highlights the importance of creative approaches in achieving economic and environmental resilience in the food sector (Moura et al., 2024). When featured in regional food and wine events, these products can enhance local producers' visibility and enrich the wine tourism experience.

To ensure access to raw materials, the model proposes partnerships with wineries to obtain calcium alginate beads at minimal cost, reinforcing the circularity of the supply chain. Additionally, the infrastructure required for processing is relatively accessible since the separation of the beads is already a part of the sparkling wine production process. Thus, the only extra steps involve

DOI: https://doi.org/10.29352/mill0219e.41097

isolating the beads from the bottle caps, followed by collection and storage. As a result, the initial investment needed is low and can be easily recovered over time through revenues from product sales and service-oriented activities. This aligns with Kuhn et al. (2024), who highlight that innovation contributes not only to value creation, but also to regional economic development.
Financial sustainability will be supported through a diversified revenue model, combining consultancy fees, sharing of profits from sales of products sold by partner producers and income generated through promotional and gastronomic events. This approach supports the development of a resilient local food economy rooted in sustainability, innovation and collaborative value creation.

4.3 Purchase intention assessment

Purchase intention is a consumer's subjective tendency to choose a product. It is composed of consumers' attitudes towards specific products and brands and external factors. As a type of consumer psychological activity, it refers to consumers' willingness and the possibility to purchase a particular product (Jia & Liu, 2018).
As shown in Figure 3, the purchase intent analysis regarding the four vinaigrette samples (V-Air, V-Water, V-Fire and V-Earth) demonstrates interesting differences between the samples. The V-Earth product recorded the highest levels of purchase intent, with 36% of participants stating they would "Probably buy" and 44% indicating they would "Certainly buy". Following this, the V-Fire sample also showed some acceptance, as 35% of potential consumers reported they would "Probably buy", while 30% stated they would "Certainly buy".
However, the V-Water vinaigrette was the most rejected, with 28% of participants declaring they would "Certainly not buy", while 26% stated they would "Probably not buy". The lower appreciation of the V-Water sample was attributed to its strong seaweed flavour. Next, the V-Air sample was the second most rejected, with 35% of respondents indicating they would "Probably not buy" and 13% stating they would "Certainly not buy", with no reason indicated.
Additionally, uncertainty regarding purchase intent ("I am unsure if I would buy") was more frequent in the V-Air sample (18%) and V-Water sample (15%), whereas V-Fire and V-Earth exhibited lower levels of uncertainty (10% and 5%, respectively).

4.4 Circularity of the solution

As noted by Moura et al. (2024), integrating circular economy principles into gastronomy can enhance regional sustainability by valorising by-products and reinforcing local networks. While often associated with the restaurant sector, gastronomy more broadly should play an active role in this paradigm. The proposed model embraces this vision by converting waste into innovative products with economic and environmental benefits.
Circularity lies at the heart of the proposed model by transforming calcium alginate beads—previously discarded during sparkling wine production—into high-value gastronomic products. This approach significantly reduces waste at wineries and opens new revenue streams for local producers. The model follows a systemic approach, incorporating the reuse or recycling of other winery materials (such as plastic bidules and metal crown caps, Figure 2), prioritising locally sourced raw ingredients and promoting more sustainable logistical practices. Additionally, the consultancy entity organises gastronomic events and awareness-raising activities that encourage the conscious use of resources and reinforce the region's culinary identity. As illustrated in Figure 4, this practice may inspire other producers in the region to seek ways of valorising waste and by-products within their production chains, potentially supported by existing local stakeholders or even by the multidisciplinary team. In this way, the model contributes to the development of a local, sustainable and economically active circular economy.

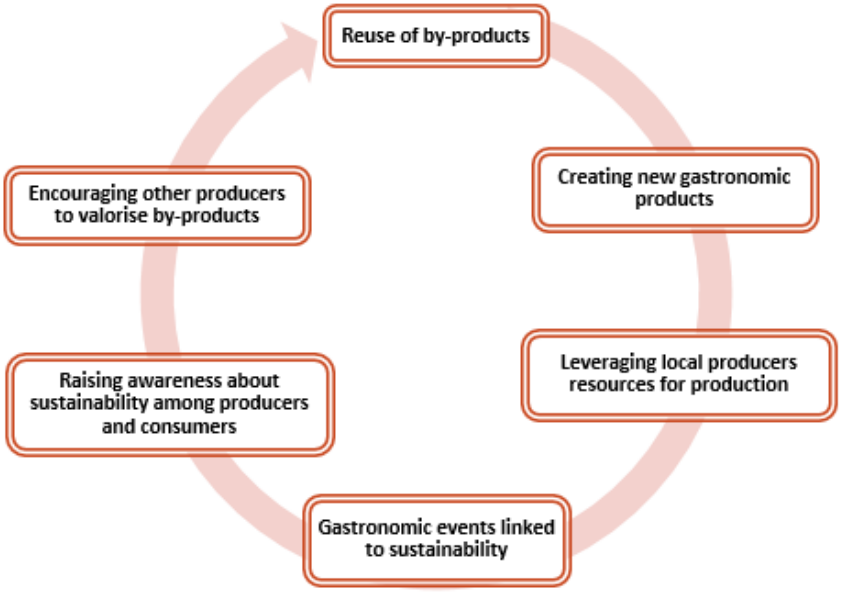

Figure 4 – Scheme of the circularity from the proposed model.

DOI: https://doi.org/10.29352/mill0219e.41097

4.5 Social impact

Renowned for its sparkling wine production, the Bairrada region has retained its traditional and rural character, with viticulture playing a central role in its economy and cultural identity (Instituto da Vinha e do Vinho, 2023).

The proposed model has the potential to generate both economic and social benefits for rural communities. Economically, the initiative can contribute to job creation, tourism growth and increased revenue by promoting local specialities. This, in turn, may encourage investment in infrastructure and local businesses, strengthening the regional economy. Socially, valorising winemaking waste fosters community pride and cultural identity, preserving traditional cuisine while promoting local cooperation and entrepreneurship. Additionally, it supports skills development within the community, enhancing professional opportunities in the food and hospitality sectors.By promoting locally sourced products, the initiative strengthens the connection between producers and consumers, fostering a sense of territorial cohesion and community engagement. These dynamics reinforce the value of co-created food experiences, which Kuhn et al. (2024) associated with enhanced tourist engagement and destination authenticity.

In fact, our model not only strengthens the region's social impact, but also contributes to positioning Bairrada as an innovative and environmentally conscious food tourism destination, capable of attracting visitors interested in sustainability-driven experiences.

4.6 Scalability and potential for replication of the model

The proposed model demonstrates strong scalability and potential for replication beyond the initial implementation context. The production of 1,000 bottles is estimated to generate approximately 1.3 kg of calcium alginate bead waste (Ribeiro, 2024, p. 8). Since sparkling wine production is an annual process, this creates a consistent opportunity for raw material recovery and valorisation. The model's flexible structure allows it to be adapted to both small-scale initiatives and larger commercial operations, depending on the resources and goals of the stakeholders involved.

The concept is not limited to the Bairrada region. It could be transferred to other wine-producing areas in Portugal and potentially to international contexts where similar production methods are used. Beyond sparkling wine by-products, our idea could also evolve to address other edible waste and by-products from other agri-food industries in the region, reinforcing the model's alignment with circular economy principles and its capacity to scale across different sectors within the local food system.

CONCLUSION

The recovery of calcium alginate beads represents a promising strategy for valorising sparkling winemaking waste, with applications in gastronomic products, such as vinaigrettes. This study highlights its potential to contribute to a more circular oenogastronomic tourism. Some vinaigrettes developed showed potential to be accepted by consumers, as shown by purchase intention assessment.

TLBMC facilitates stakeholder engagement by mapping key partnerships, such as collaborations with local wineries and restaurants, suppliers of local ingredients or recycling networks. It also ensures economic viability, balancing profitability with ecological and social responsibility.

By structuring a business model that integrates sustainable innovation, the Canvas Model empowers entrepreneurs to align circular economy principles with consumer demands, regulatory frameworks and long-term business resilience. Its adaptability makes it a valuable tool for creating scalable, impact-driven gastronomic ventures that contribute to a more sustainable food system.

This approach addresses waste reduction and circular economy goals and could provide more innovative gastronomic products for restaurants, wineries and other local players to enhance the oenogastronomic tourism in the Bairrada region.

ACKNOWLEDGEMENTS

CERNAS (https://doi.org/10.54499/UIDP/00681/2020) and the strategic project UID/AGR/04129/2020 (LEAF), which are supported by the FCT - Foundation for Science and Technology. I.P. Biorural "Accelerating circular bio-based solutions integration in European rural areas" (reference: 101060166) financed by European Research Executive Agency following HORIZON-CL6-2021-CIRCBIO-01. Adega Cooperativa de Cantanhede Crl, Aromas & Boletos Lda. and Mendes Gonçalves S.A. for some ingredients supply.

AUTHORS' CONTRIBUTION

Conceptualization, C.F. and G.B.; data curation, C.P. and G.B.; formal analysis, C.P. and G.B.; funding acquisition, C.P. and G.B.; investigation, C.P. and G.B.; methodology, C.P. and G.B.; project administration, C.P. and G.B.; resources, C.P., T.R., C.P. and G.B.; software, C.P. and G.B.; supervision, C.P. and G.B.; validation, C.P., T.R., J.S., C.P. and G.B.; visualization, C.P. and G.B.; writing - original draft, C.P. and G.B.; writing - review and editing, C.P., T.R., J.S., C.P. and G.B.

DOI: https://doi.org/10.29352/mill0219e.41097

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Alessandroni, L., Bellabarba, L., Corsetti, S., & Sagratini, G. (2024). Valorization of *Cynara cardunculus* L. var. *scolymus* processing by-products of typical landrace "Carciofo Di Montelupone" from Marche region (Italy). *Gastronomy, 2*(4), 129–140. https://doi.org/10.3390/gastronomy2040010

Habashi, F. (2000). Zoroaster and the theory of four elements. *Bulletin for the History of Chemistry, 25*(2), 109–115. https://doi.org/10.70359/bhc2000v025p109

Hastjarjo. (2024). Enhancing sustainability with triple-layered business model canvas in gastronomy agro-tourism Sukajadi Village Bogor. *Jurnal Aplikasi Manajemen dan Bisnis, 10*(2), 530. http://dx.doi.org/10.17358/jabm.10.2.530

Højlund, S., & Mouritsen, O. G. (2025). Sustainable cuisines and taste across space and time: Lessons from the past and promises for the future. Gastronomy, 3(1), 1. https://doi.org/10.3390/gastronomy3010001

Instituto da Vinha e do Vinho I. P. (2024). *Evolution of national wine production by wine region: Series 2009/2010 to 2023/2024*. https://www.ivv.gov.pt/np4/36/

Instituto da Vinha e do Vinho I. P. (2023). *Vinhos e Aguardentes de Portugal*. Enigma Editores. https://www.ivv.gov.pt/np4/Anu%C3%A1rio/

International Organization for Standardization (ISO). (2014). *Sensory analysis – Methodology – General guidance for conducting hedonic tests with consumers in a controlled area* (ISO 11136:2014). https://www.iso.org/standard/50117.html

Jantsch, L., Flores, S. S., & Vale, Z. N. (2024). Local gastronomy and wine geographical indications (GIs): Framework for identifying pairing potential. *International Journal of Gastronomy and Food Science, 35*, Article 100856. https://doi.org/10.1016/j.ijgfs.2023.100856

Jia, Y., & Liu, I. (2018). Do consumers always follow “useful” reviews? The interaction effect of review valence and review usefulness on consumers’ purchase decisions. *Journal of the Association for Information Science and Technology, 69*(10), 1304–1317. https://doi.org/10.1002/asi.24074

Joyce, A., & Paquin, R. L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *Journal of Cleaner Production, 135*, 1474–1486. https://doi.org/10.1016/j.jclepro.2016.06.067

Kim, Y. G., Eves, A., & Scarles, C. (2009). Building a model of local food consumption on trips and holidays: A grounded theory approach. *International Journal of Hospitality Management, 28*(3), 423–431.https://doi.org/10.1016/j.ijhm.2008.11.005

Mikinac, K., Laškarin Ažić, M., & Rašan, D. (2022). Enogastronomic experience: A state-of-the-art review. In V. Bevanda (Ed.), *International Scientific-Business Conference – LIMEN 2022: Vol 8. Selected papers* (pp. 103–113). Association of Economists and Managers of the Balkans. https://doi.org/10.31410/LIMEN.S.P.2022.103

Moreno-García, J., García-Martínez, T., Mauricio, J. C., & Moreno, J. (2018). Yeast immobilization systems for alcoholic wine fermentations: Actual trends and future perspectives. *Frontiers in Microbiology, 9*, 241. https://doi.org/10.3389/fmicb.2018.00241

Moura, A., Costa, V., Devile, E., Camões, H., Maia, B., & Melo, C. (2024). Exploring the intersection between circular economy, gastronomy and sustainability: A review of current discourse. *Journal of Tourism & Development, 46*, 41–59. https://doi.org/10.34624/rtd.v46i0.32837

Naderi, N., Naderi, N., Boo, H. C., Lee, K.-H., & Chen, P.-J. (2024). Editorial: Food tourism: Culture, technology and sustainability. *Frontiers in Nutrition, 11*, Article 1390676. https://doi.org/10.3389/fnut.2024.1390676

Okumus, B., Koseoglu, M. A., & Ma, F. (2018). Food and gastronomy research in tourism and hospitality: A bibliometric analysis. *International Journal of Hospitality Management, 73*, 64–74.

Ribeiro, T. C. (2024). *Controlo da qualidade de vinho e de vinagretes formulados para valorizar um subproduto da produção de vinhos espumantes* [Dissertação de Mestrado, Escola Superior Agrária de Coimbra].

Robinson, R. N. S., Getz, D., & Dolnicar, S. (2018). Food tourism subsegments: A data-driven analysis. *International Journal of Tourism Research, 20*, 367–377. https://doi.org/10.1002/jtr.2188

Santos, E., Café, M., Lopes, A. B., & Botelho, G. (2025). Wine tourism hotspot: A case study with a small Portuguese family-owned company. *Acta Horticulturae, 1418*, 375–380. https://doi.org/10.17660/ActaHortic.2025.1418.47

Tsai, C.-T., & Wang, Y.-C. (2017). Experiential value in branding food tourism. *Journal of Destination Marketing & Management, 6*, 56–65. https://doi.org/10.1016/j.jdmm.2016.02.003

Kuhn, V. R., dos Anjos, S. J. G., & Krause, R. W. (2024). Innovation and creativity in gastronomic tourism: A bibliometric analysis. *International Journal of Gastronomy and Food Science*, 35, 100813. https://doi.org/10.1016/j.ijgfs.2023.100813