International Journal of Gastronomy and Food Science 42 (2025) 101337

Contents lists available at ScienceDirect

International Journal of Gastronomy and Food Science

journal homepage: www.elsevier.com/locate/ijgfs

Carbon footprint assessment of the Isparta ceremonial Menu: Preserving tradition through sustainability

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ARTICLE INFO

Keywords:
Sustainable gastronomy
Carbon footprint
Traditional dishes
Isparta *çatallı* ceremonial menu

ABSTRACT

Serving food to guests in open areas during special occasion ceremonies continues to exist as a sustainable tradition in Turkey. In the context of sustainable gastronomy, it is important to assess the environmental impacts of such rituals, which are held with large public participation. This study aims to evaluate the carbon footprint (CF) of the *Çatallı Wedding Menu*, a traditional gastronomic example specific to Isparta province, within the framework of sustainable gastronomy. In the research, the standard recipes of the dishes included in the menu were taken as a basis for CF calculations, and their environmental impacts were analyzed. The CCaLC2 1700 (2016) software, which contains ready-to-use datasets, was utilized in the calculations. According to the findings, the CF value of the "Düğün" soup was determined as 0.4495 kg CO_2e/portion, while that of *zerde* dessert—a rare sweet containing meat broth—was 0.3155 kg CO_2e/portion. In most dishes on the menu, animal-based ingredients were identified as the main source of CF. In particular, meat-heavy dishes such as *banak* (3.61 kg CO_2e/portion) and okra stew (1.08 kg CO_2e/portion) stood out with high greenhouse gas emissions. The results indicate that the carbon footprint of gastronomic products varies significantly depending on the raw materials used. The findings suggest that prioritizing local, seasonal, and plant-based ingredients in menu planning could be an effective strategy to reduce CF. Recipe modifications and menu designs that aim to lower the carbon footprint while preserving gastronomic heritage are of critical importance for sustainable gastronomy.

1. Introduction

Global warming and climate change are among the most pressing environmental issues requiring urgent action for the sake of future generations. All production processes, particularly in sectors such as agriculture, livestock farming, food production, fisheries, and forestry, are affected by climate change (Kaman and Bozkurt, 2025). Consequently, the concepts of ecological sustainability and sustainable nutrition have gained increasing importance in recent years. The agricultural sector is one of the most critical fields in terms of sustainability (Aydın, 2023). Activities such as preparation, transportation, and storage of food, from production to consumption, contribute to the formation of greenhouse gases. For this reason, ecological sustainability and sustainable nutrition have increasingly become central themes in dietary recommendations and menu planning (Willet et al., 2019).

The primary cause of global warming is greenhouse gas (GHG) emissions generated by human activities (IPCC, 2014). The agricultural sector, industries related to food production, and the tourism sector together account for a significant share of these emissions. While agriculture alone is responsible for approximately 20 % of global GHG emissions (FAO, 2020), food production can account for up to one-third of total emissions (Crippa et al., 2021; Vermeulen et al., 2012). According to Lenzen et al. (2018), the carbon footprint of tourism increased by an average of 3.5 % per year between 2009 and 2013, and Sun et al. (2024) reported that tourism accounts for about 8.8 % of global GHG emissions. The processes of producing, processing, transporting, and consuming food contribute to GHG emissions in both the agricultural and foodservice sectors due to the use of fossil fuels and other energy sources (Bschaden et al., 2024). Gastronomy tourism constitutes an important part of this system and addressing

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https://doi.org/10.1016/j.ijgfs.2025.101337
Received 13 August 2025; Received in revised form 8 October 2025; Accepted 20 October 2025
Available online 22 October 2025

environmental impacts (particularly reducing the carbon footprint) is critical to achieving sustainable gastronomy goals. The sustainable gastronomy approach supports local production and consumption while promoting low-carbon practices, thereby contributing to the reduction of environmental impacts in the tourism sector (Scarpato, 2002).

Holistic cuisine is an interdisciplinary study in the field of gastronomy, encompassing different fields from natural sciences to social sciences, aimed at understanding food and gastronomic experiences (Rodríguez et al., 2023; Fooladi et al., 2019; Mestre et al., 2022). Traditional ceremonial menus belonging to a particular region are among the most significant examples of cultural gastronomy (Sgroi, 2023). Menus prepared for weddings, holidays, funerals, and religious or ethnic celebrations play a crucial role in transmitting cultural memory to future generations, thus contributing to the sustainability of gastronomic heritage. In many regions of Turkey, particularly in rural areas, the tradition of preparing and serving meals outdoors over wood fires for guests continues to this day (Budak and Özkaya, 2024). The aim of this study is to analyze a traditional wedding ceremony menu in terms of its carbon footprint (CF) and to evaluate it from a sustainable gastronomy perspective. Specifically, the study focuses on the *Çatallı Wedding Menu* unique to Isparta Province, located in the Mediterranean Region of Turkey. Standard recipes for the dishes in this menu were used to calculate CF values, and recommendations were developed for dishes with high CF levels. Such menus typically contain large amounts of meat, baked goods, and desserts, which can significantly increase their carbon footprint. The limited number of studies in the literature addressing CF in traditional gastronomy menus enhances the originality of this research. Ultimately, the study aims to raise awareness and promote Isparta/Turkey's gastronomy tourism and local cuisine, propose sustainable alternatives for high-CF dishes, and contribute to the literature as a resource for individuals seeking guidance on sustainable eating practices.

1.1. Gastronomy tourism

Gastronomy tourism attracts visitors seeking local cuisine as an expression of regional cultural identity (Hillel et al., 2013). In the competitive tourism market, branding distinctive gastronomic elements is an effective strategy to appeal to culinary-oriented travelers and to emphasize differences between gastronomic routes (Berg and Sevón, 2014). The concept of gastronomic heritage frames these distinctions, as each community's cuisine (shaped by cultural background, geography, and history) comprises traditions, customs, recipes, dishes, cooking techniques, utensils, and culinary narratives (Dixit, 2021).

Rural tourism plays a key role in advancing sustainability within gastronomy tourism by prioritizing local and seasonal ingredients, supporting organic farming, and reducing food waste (Darius, 2023). It promotes environmental protection and awareness of sustainable food systems, while the UNWTO (2022) highlights its potential to revitalize rural communities, support local producers, and foster regional development.

1.2. Gastronomy and sustainability

The FAO defines sustainable diets as low-impact dietary patterns that support food and nutrition security (FAO, 2022), while the WHO describes them as protective of biodiversity, culturally acceptable, accessible, economically fair, affordable, nutritionally adequate, safe, and healthy (WHO, 2019). Aligned with these principles, the United Nations' Sustainable Development Goals (United Nations, 2015) include ending hunger, improving nutrition, and promoting sustainable agriculture (Grosso et al., 2020), which aim to conserve resources, encourage local production, and increase seasonal consumption (Dernini, 2019; Gussow and Clancy, 1986).

In sustainable gastronomy, promoting sustainable agriculture and using local products are essential for supporting regional economies and enhancing dish recognition (Gün and Kılıç, 2023). This holistic approach involves preserving food resources, reducing waste, conserving energy, and adopting low-carbon diets (Scarpato, 2002; Pramezwarya and Ayuningsih, 2019). Yet, climate change, pollution, food safety issues, population growth, and declining farmland threaten sustainability, making the protection of resources and gastronomic heritage crucial.

Sustainable gastronomy seeks to ensure the environmental, social, and economic viability of food systems through strategies spanning production to consumption. Carbon footprint assessments, addressing local production, seasonality, waste reduction, and ethical supply chains, are key to setting emission reduction targets and advancing sustainability.

1.3. Gastronomy tourism and special day/ceremonial meals in Isparta

In Turkey, culinary culture is shaped by regional geography and local traditions, with distinctive cuisines alongside shared dishes (Arman, 2011). Isparta, enriched by its historical civilizations, agricultural diversity, and tourism potential, ranks among the country's notable gastronomy destinations (Budak et al., 2025). The city significantly contributes to the national economy through rose production and rose-based products, while recent rose harvest festivals have become key events supporting regional tourism (Giray and Kart, 2012).

The culinary repertoire of Isparta prominently features cooking methods such as roasting, baking, boiling, and frying. A traditional preservation technique in the region involves roasting small and large ruminant meat and storing it in its own fat (Isparta Governorship Provincial Directorate of Culture and Tourism, 2014; Budak and Özkaya, 2024).

Special days and ceremonies celebrated in Isparta include births, weddings, circumcisions, funerals, religious nights, religious holidays, farewell and welcoming ceremonies, and seasonal festivals (Budak and Özkaya, 2024). Ceremonial meals are generally planned for 1000–2000 people, with preparations beginning the night before, and cooking performed under the supervision of professional chefs. Meals cooked in large cauldrons are served in the morning, accompanied by prayers. These street-style dishes are prepared over wood fires using traditional methods, which impart a distinctive flavor and cultural value (Fig. 1).

In Isparta, ceremonial meals are served in two distinct formats: the "Kaşıklı" (spoon) menu and the "Çatallı" (fork) menu. To convey the content of the ceremonial meal, guests often ask, *"Is it a spoon menu or a fork menu?"*. Dishes in the Kaşıklı menu are primarily consumed with a spoon, whereas the main courses in the Çatallı menu are eaten with a fork. Within the local community, the terms "Kaşıklı" and "Çatallı" function as a cultural code, serving as an informal yet widely recognized method of identifying the type of meal to be served. The *Çatallı menu* is generally preferred as a wedding meal by families with higher socioeconomic status, due to the high cost of the ingredients and meat used. The *Kaşıklı menu* typically includes yoğurtlu pirinç çorbası (yogurt and rice soup) as the soup, kuşbaşılı kuru fasulye (cubed meat with white beans) as the main course, kabune (rice pilaf with meat) as the pilaf dish, and irmik helvası (semolina halva) as the dessert. The *Çatallı menu*, on the other hand, consists of düğün soup (rice wedding soup) as the soup, banak and bamya yemeği (okra stew) as the main courses, bulgur pilaf prepared with meat broth as the pilaf dish, and zerde (cinnamon-flavored rice dessert) enriched with meat broth as the dessert (Budak et al., 2025; Budak and Özkaya, 2024).

1.4. The Isparta Çatallı Menu for ceremonial meals

The richness of Isparta's culinary culture is distinctly reflected in its ceremonial meals. The *Çatallı Menu for Ceremonial Meals* examined in this study, along with its preparation process, was compiled using the archives of the Turkish Patent and Trademark Office (2024) and the book *Isparta Özel Gün Gastronomisi* (Budak and Özkaya, 2024), and is presented in Table 1. Photographs of the dishes, ready for consumption

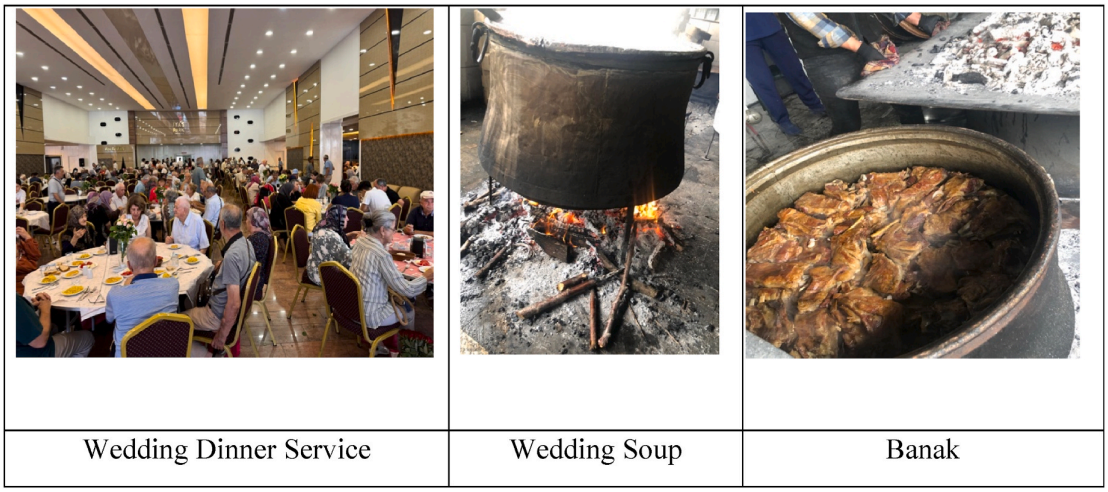

Fig. 1. Preparation and presentation process of the *Çatallı Menu* ceremonial dishes.

after preparation, are provided in Fig. 1.

In Isparta ceremonial cuisine, wood or vine branches are the main cooking fuel, and large copper cauldrons -selected based on guest numbers-maintain heat efficiently due to copper's high thermal conductivity (Lugo and Oliva, 2016; Minneci et al., 2020). Slow cooking in these cauldrons preserves nutritional quality and enhances sensory attributes, while chefs' expertise remains crucial in achieving the dishes' characteristic flavors (Budak and Özkaya, 2023).

The *Çatallı Menu* in Isparta's ceremonial meals always includes *banak* and okra stew. The meats used in these dishes are sourced from cattle and small ruminants that graze on thyme and vetch, reflecting the region's mountainous and forested landscape. *Banak*, one of Isparta's geographically indicated ceremonial dishes, is among the most favored delicacies of the local community and is traditionally prepared by local chefs over an open ground fire. It consists of boiled chunks of meat cooked over a wood fire. This geographically indicated product is registered under two names: "Uluborlu Banağı" and "Senirkent Banağı." While the cooking method is identical, Senirkent Banağı uses beef from young heifers, whereas Uluborlu Banağı uses goat meat from animals fed on thyme (Budak and Özkaya, 2024).

Dairy products from locally raised livestock (such as yogurt, clotted cream, and butter) are integral to Isparta's cuisine and widely used in ceremonial meals. Poppy seed oil also helps preserve traditional flavors. Zerde, a unique dessert cooked with meat broth, is included in these meals, though the meat's taste and aroma are not discernible (Budak and Özkaya, 2024).

1.5. The concept of carbon footprint and its reflections on the food production chain

Greenhouse gases (GHGs) significantly contribute to global warming, threatening future generations (Bein et al., 2020). Without action, temperatures could rise over 3 °C by 2100. Under the 2015 Paris Agreement, 196 countries, including Turkey, pledged to limit warming to 2 °C, ideally 1.5 °C (United Nations, 2015). The EU targets net-zero GHG emissions by 2050 (European Commission, 2010).

The carbon footprint quantifies total greenhouse gas emissions from human activities, expressed as carbon dioxide equivalents (CO_2e) (Wiedmann and Minx, 2008; Coskun and Dogan, 2021). Under the Kyoto Protocol, these gases include CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 (Patel, 2006; Downie and Stubbs, 2012). Their warming effects vary based on radiative forcing and atmospheric lifetime, expressed as global warming potential (GWP) relative to CO_2 and measured in CO_2e (Downie and Stubbs, 2012).

Agricultural production accounts for about 60 % of food supply chain GHG emissions (Risku-Norja et al., 2009). Animal-based foods produce higher emissions, with meat and dairy contributing ~14.5 % of global totals (Gerber et al., 2013). At the retail stage, carbon footprints range from 10.0 to 14.0 kg CO_2e/kg for beef, butter, and cheese; 4.8–5.0 for poultry and fish; 2.2–3.2 for eggs, oils, and rice; 0.9–1.4 for milk, bread, pasta, and cereals; and 0.3–0.8 for fruits and vegetables (Mogensen et al., 2020).

2. Methodology

In this study, the carbon footprint (CF) of the dishes included in the *Çatallı Menu* of Isparta's ceremonial cuisine was calculated based on the ingredients listed in their standardized recipes. The CCaLC2 1.700 (2016) software, a carbon footprint analysis tool, was used for the calculations. CCaLC2 software uses emission factors from extensive international databases (Ecoinvent, ILCD, etc.) compatible with ISO 14044 and PAS2050. The program calculates the global warming potential of different activities through these databases (Bansod et al., 2024; Thapa et al., 2022). The databases in CCaLC2 allow for the selection of different preferences during the calculation phase, including data on materials, energy, transportation, packaging, and waste (Córdova-Suárez et al., 2025; Guinée, 2001)." Transportation, storage, and waste processes were excluded from the scope of the analysis. For ingredients present in very small quantities, such as salt and spices, CF values were calculated based on the recipe for 1000 servings and incorporated into the total value. Although lamb meat can optionally be used in *banak*, the calculations in this study were conducted using bone-in beef. The methodological framework was adapted from Ural (2023) and Budak et al. (2025).

The CF values obtained from the software, based on the ingredient weights in each recipe, were evaluated per serving and then multiplied to estimate the total CF for 1000 servings. The results are presented as carbon dioxide equivalents (CO_2e). To facilitate comparison between the CF values of different dishes, a per-serving evaluation approach was adopted. This method is widely applied in both national (Erdoğan, 2018; Taş Özdemir, 2020; Ural, 2023; Budak et al., 2025) and international studies (Spaargaren et al., 2013; Clune et al., 2017) because it provides a more detailed perspective.

Information on the *Çatallı Menu* dishes was obtained from Budak and Özkaya (2024) in their book *Isparta Özel Gün Gastronomisi*. CF calculations were performed using the quantities specified in the standardized recipes archived by the Turkish Patent and Trademark Office. Standardized recipes ensure consistent quality when a dish is prepared in

Table 1
Isparta "*Çatallı*" ceremonial meal menu (Budak and Özkaya, 2024).

Dish Categories	Preparation Method
"Düğün" Soup	• Rice is boiled in water. • Cooked chickpeas and meat broth are added and simmered until well blended. • Salt is added. • In a separate pan, clotted cream butter and regular butter are melted and heated until sizzling. • Tomato paste and black pepper are added to the hot butter. • The soup is ladled into bowls, and the butter mixture is drizzled on top. • Optionally, garnished with parsley before serving.
Okra Stew	• Okra is cleaned and trimmed. • Diced meat is sautéed in a separate pot. • Onions are diced and lightly sautéed in poppy seed oil. • Okra and lemon juice are added to the onions and cooked. • Meat and tomato paste are incorporated and the mixture continues to cook. • Salt is added before finishing cooking. • The prepared okra dish is served by placing it on flat plates.
Banak	• Bone-in beef shank (or optionally lamb neck, shoulder, or ribs) is boiled in a copper cauldron over a wood fire. • Whole peeled onions are added to the cauldron during cooking. • Foam is skimmed off using a special ladle called "*ilistir*". • "*Tırnak pide*" (flat tandoor bread), prepared a day earlier, is cut into finger-sized pieces and placed on serving plates. • Meat broth is poured over the bread, drained, and repeated once more. • The bread is moistened just before serving to prevent sogginess. • Large chunks of meat are placed on top and served.
Bulgur Pilaf	• Onions are sautéed. • Butter is added, then bulgur is incorporated and lightly sautéed. • Meat broth and water are added, and the pilaf is cooked over a wood fire. • Salt and black pepper are added. • The cooked pilaf is rested before serving. • Served in special pilaf plates, sprinkled with black pepper.
Zerde (Sweet Saffron Rice Pudding)	• Rice is boiled in water until tender. • Wheat starch, sugar, and meat broth are added and cooking continue. • Once thickened, it is left to cool. • Poured into small serving bowls. • Sprinkled with cinnamon before serving.

different parts of the country, allow for its scientific preparation, and ensure the documentation of its ingredients. This facilitates the recording of recipes, improves cost control in foodservice operations, preserves culinary authenticity for transmission to future generations, and supports the geographical indication registration process (Çekal and Doğan, 2022).

3. Findings and discussion

In this study, the carbon footprint (CF) values of the dishes included in the *Isparta Çatallı Menu* of ceremonial cuisine (Düğün Soup, Okra Stew, Banak, Bulgur Pilaf, and Zerde) were analyzed. Table 2 presents the ingredients from the standardized recipes of these dishes and their corresponding per-serving CF values. The contribution of salt, spices, and cinnamon (used in the dessert) to the per-serving CF was found to be negligible in calculations performed using the CCaLC2 1.700 software. Therefore, these ingredients were not listed as separate items in the table 2. However, considering that ceremonial meals in Isparta and its surrounding areas are typically prepared for at least 1000 people, the CF values calculated based on the total quantities of these ingredients are presented in Table 3. The per-serving and total ceremonial meal CF values for the entire menu are shown in Table 4.

All dishes included in the *Çatallı Menu* of the Isparta ceremonial cuisine were found to contain either meat or meat broth. Analysis of the menu revealed that the majority of the total carbon footprint (CF) originated from the inclusion of meat and meat broth. Specifically, the contribution of meat broth in the soup to the total CF was calculated as 3

Table 2
Carbon footprint (CF) calculation of the *Çatallı Menu* in Isparta ceremonial cuisine.

Düğün Soup		
Ingredients	Standard Recipe Amount (g)	kg CO_2/product (amount used)
Rice	180	0.282
Meat Broth	480	3
Cooked Chickpeas	165	0.158
Clotted Cream Butter	15	0.105
Butter	15	0.015
Tomato Paste	20	0.036
Salt[a]	3	–
Black Pepper[a]	2	–
Total (8 serving)		3.596
Okra Stew		
Ingredients	**Standard Recipe Amount (g)**	**kg CO_2/product (amount used)**
Okra	1000	3.29
Diced Meat	250	7.18
Lemon juice	50	0.200
Tomate Paste	20	0.036
Poppy Seed Oil	20	0.052
Onion	150	0.075
Salt[a]	3	–
Total (10 servings)		10.833
Banak		
Ingredients	**Standard Recipe Amount (g)**	**kg CO_2/product (amount used)**
Bone-in Beef Shank	2000	54
Flatbread (Tırnak Pide)	150	0.090
Onion	150	0.075
Salt[a]	3	–
Black Pepper[a]	2	–
Total (15 servings)		54.165
Bulgur Pilaf		
Ingredients	**Standard Recipe Amount (g)**	**kg CO_2/product (amount used)**
Bulgur	160	0.096
Meat Broth	240	1.50
Butter	15	0.015
Onion	150	0.075
Salt[a]	3	–
Black Pepper[a]	2	–
Total (4 servings)		1.686
Zerde		
Ingredients	**Standard Recipe Amount (g)**	**kg CO_2/product (amount used)**
Rice	90	0.141
Water	600	–
Meat Broth	600	3.75
Wheat Starch	5	0.0055
Sugar	200	0.836
Cinnamon[a]	2	–
Total (15 servings)		4.7325

[a] The per-serving CF contribution of spices and salt was negligible and thus not calculated in the table; however, their total impact was included in the CF calculation for 1000 servings of the ceremonial meal.

Table 3
Impact of spices on the per-serving and total carbon footprint of the ceremonial meal.

Ingredients			
Total (1000 servings)	**Salt (g)**	**Black Pepper (g)**	**Cinnamon (g)**
Düğün Soup	273	182	–
Okra Stew	714	–	–
Banak	429	288	–
Bulgur Pilaf	273	288	
Zerde	–	–	182
Total CF (kg CO_2e/1000 servings)			
	Salt	**Black Pepper**	**Cinnamon**
Düğün Soup	0.08	0.05	–
Okra Stew	0.21	–	–
Banak	0.13	0.09	–
Bulgur Pilaf	0.08	0.09	
Zerde	–	–	0.05

Table 4
Carbon footprint (CF) values of the dishes in the Isparta *Çatallı Menu* ceremonial meal.

Dish	Standard Recipe Serving Size (g)	Per Serving CF (kg CO_2e)	Total for Ceremony (1000 servings, kg CO_2e)
Düğün Soup	100	0.4495	449,63
Okra Stew	150	1.083	1083,51
Banak	150	3.611	3611,22
Bulgur Pilaf	150	0.4215	421,67
Zerde	100	0.3155	315,55

Values were calculated using the CCaLC2 1.700 application. The per-serving CF contribution of salt and spices was negligible; hence, they are not included in the table but were considered in the total CF calculation for 1000 servings.

kg CO_2/product (approximately 83.43 %); diced meat in okra stew contributed 7.18 kg CO_2/product (approximately 66.28 %); beef in *banak* accounted for 54 kg CO_2/product (approximately 99.7 %); and meat broth in bulgur pilaf contributed 1.50 kg CO_2/product (approximately 88.97 %).

When evaluated by product, the findings were consistent with values reported in the literature. In this study, the CF of *Rice Wedding Soup* was calculated as 0.4495 kg CO_2e/serving. Comparable values reported in previous studies include: yogurt-based rice soup at 0.370 kg CO_2e/serving (Budak et al., 2025), traditional Elazığ soups ranging from 0.04 to 0.28 kg CO_2e/kg (Ural, 2023), Tuscan soup with meatballs at 1 kg CO_2e/serving, pea soup with sausage at 0.9 kg CO_2e/serving, goulash soup with beef at 0.9 kg CO_2e/serving, and chicken soup at 0.72 kg CO_2e/serving (Spaargaren et al., 2013). Although CF values vary depending on the standardized recipes, soups containing meat or meat products consistently exhibit higher CF levels.

The CF of *banak* was calculated at 3.61 kg CO_2e/serving. Similar studies have reported CF averages for kebabs and large-cut meat dishes in Türkiye ranging from 3.22 to 3.37 kg CO_2e/serving (Erdoğan, 2018), while Ural (2023) reported a maximum CF of 3.61 kg CO_2e/serving for main dishes in Elazığ province. Outside of large-cut meat dishes, main course CF values were found to be 2.38 kg CO_2e/serving for Ankara Döner (Durlu-Özkaya et al., 2024) and 2.37 kg CO_2e/serving on average for meatball-based dishes (Taş Özdemir, 2020).

Within the Isparta *Çatallı Menu*, okra stew had a CF value of 1.08 kg CO_2e/serving, while bulgur pilaf had 0.42 kg CO_2e/serving. Previous research has also indicated that pilafs and plant-based dishes generally produce lower emissions. In a systematic review, Clune et al. (2017) reported that vegetable-based dishes had an average CF range of 0.5–2 kg CO_2-eq/kg. However, when such low-CF dishes are combined with animal-based products, their environmental impact increases significantly.

Zerde, one of the few desserts containing meat broth, had a CF value of 0.3155 kg CO_2e/serving. Meat broth accounted for 79.23 % of the total CF, while sugar contributed approximately 17.7 %. In comparison, the CF of semolina halva with butter (part of the Isparta spoon-served ceremonial dishes) was reported as 0.149 kg CO_2e/serving (Budak et al., 2025). Average CF values for desserts in Türkiye have been reported as 0.06–0.57 kg CO_2e/serving (Ural, 2023) and 0.18 kg CO_2e/serving (Taş Özdemir, 2020). Such differences are largely attributable to variations in recipe composition and serving sizes.

To reduce carbon footprint (CFP) values, several measures can be implemented, including improving energy efficiency in production processes through the use of high-efficiency equipment, integrating renewable energy sources, and reducing water consumption (Omer, 2008); shortening transportation distances (Gössling et al., 2011); opting for more sustainable packaging materials, such as paper or glass, which are more readily biodegradable; and capturing carbon emissions for underground storage instead of releasing them into the atmosphere (Gabrielli et al., 2020).

While preserving gastronomic traditions, recipe modifications and menu planning aimed at lowering the carbon footprint are of strategic importance for sustainable gastronomy. Promoting the use of local products in culinary preparations can help mitigate transportation-related carbon emissions. The prevalence of local ingredient use in restaurants is directly associated with the operators' knowledge and experience regarding local dishes (Manachi-Chatibura and Saayman, 2015). Moreover, developing policies to reduce the costs of local products is another critical consideration, as their high costs are identified as a hindering factor in carbon emission reduction efforts (Curtis and Cowee, 2009; Presenza and Del, 2013).

4. Conclusion

In Türkiye, traditional ceremonial meals that continue to be practiced with high communal participation serve as special events symbolizing unity and solidarity. This study aimed to identify environmental, social, and economic emission reduction targets and strategies to ensure the sustainability of the Isparta "çatallı" ceremonial meal, recognized as an example of traditional gastronomy, and to contribute to the preservation of traditional culinary culture.

The study calculated the approximate carbon footprints of selected traditional dishes. A limitation of the study was the lack of any sampling process, statistical analysis, or probabilistic modeling. Another limitation is that the carbon footprint assessment was conducted on a limited sample of traditional city-specific products.

The findings indicate that in the Isparta "çatallı" ceremonial menu, the majority of the carbon footprint (CFP) originates from the use of animal-based products, particularly meat and meat broth. The results demonstrate that dishes containing meat products have significantly higher carbon footprints. For sustainability in gastronomy, it is crucial to consider environmental impacts both in menu planning and in recipe formulation. Selecting more sustainable and eco-friendly ingredients, prioritizing plant-based components, and choosing locally sourced and seasonal products are projected as key steps toward reducing the CFP. Furthermore, sustainable agricultural practices, reduction of food waste, prevention of overconsumption, public awareness initiatives, consumer education, and the implementation of recycling and zero-waste policies are essential measures that can enable sustainable gastronomy. Reducing the use of chemical fertilizers and pesticides, improving the efficiency of water and energy use in food production, and promoting sustainability-focused policies and practices in the gastronomy sector will provide tangible contributions to mitigating environmental impacts.

5. Policy implications

The results of this study hold direct relevance for policymakers, local governments, and stakeholders in the gastronomy and hospitality industries. Integrating carbon footprint monitoring into menu planning for traditional and ceremonial meals could serve as a benchmark for reducing environmental impacts while safeguarding cultural heritage. Local authorities may enhance sustainability by incentivizing the use of locally sourced, seasonal, and plant-based ingredients in large-scale public events through subsidies, recognition programs, or sustainability certification schemes. Additionally, embedding sustainability modules into culinary education and professional chef training can foster long-term behavioral change in menu design and ingredient selection. At the policy level, the development of region-specific sustainable gastronomy guidelines (supported by quantitative carbon footprint data) would facilitate more targeted interventions, ensuring the dual objectives of preserving intangible cultural heritage and contributing to national and global climate goals.

6. Implications for gastronomy

The findings of this study hold significant implications for the field of gastronomy, particularly in the context of sustainable menu design, culinary heritage preservation, and gastronomic tourism development. First, the carbon footprint (CF) analysis of the Isparta Çatallı ceremonial menu demonstrates that traditional gastronomy can and should be evaluated through a sustainability lens without compromising its cultural authenticity. This offers chefs, restaurateurs, and gastronomy professionals a data-driven foundation for modifying recipes, substituting high-emission ingredients, and incorporating plant-based alternatives while retaining sensory and cultural integrity.

For culinary education and professional training, the results highlight the necessity of integrating environmental impact assessments such as carbon footprint calculations into curriculum design. By equipping future chefs with the skills to evaluate and reduce the environmental impacts of their dishes, the sector can foster a new generation of sustainability-conscious professionals. This aligns with broader global trends toward climate-responsible dining and strengthens the competitive positioning of gastronomic destinations that adopt such practices.

In the domain of gastronomic tourism, the study underscores the potential to market destinations not only for their unique flavors and culinary traditions but also for their commitment to environmental stewardship. Presenting traditional menus with documented sustainability metrics can appeal to eco-conscious travelers, thereby enhancing destination branding. Furthermore, collaborations between local producers, tourism operators, and gastronomy professionals can encourage the use of local, seasonal, and low-impact ingredients, reducing transportation-related emissions and supporting the local economy.

Lastly, these insights can inform policy frameworks that bridge cultural heritage preservation with environmental responsibility. Establishing sustainability guidelines for large-scale ceremonial menus and incentivizing low-carbon culinary practices can serve as a replicable model for other regions. As gastronomy continues to evolve in response to climate change, integrating sustainability into traditional culinary practices will not only safeguard intangible cultural heritage but also ensure its viability for future generations.

CRediT authorship contribution statement

Nilgün H. Budak: Writing – review & editing, Writing – original draft, Resources, Methodology, Formal analysis, Data curation. **Sezen Coskun:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Mehmet Berk Varol:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Fügen Durlu Özkaya:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

Arman, A., 2011. Publicity Problem of the Turkish Cuisine Culture: the Example of Mengen Cuisine (Tez Number 290095) [Master thesis, division of Tourism and Hotel Managament, Düzce University]. Thesis Center Council of Higher Education, Türkiye.

Aydın, A., 2023. Calculation of greenhouse gas emissions from agriculture; enteric fermentation. International Journal of Food, Agriculture and Animal Sciences (IJFAA) 3 (1), 40–54.

Bansod, Y., Crabbe, B., Forster, L., Ghasemzadeh, K., D'Agostino, C., 2024. Evaluating the environmental impact of crude glycerol purification derived from biodiesel production: a comparative life cycle assessment study. J. Clean. Prod. 437 (140485), 1–15.

Bein, T., Karagiannidis, C., Quintel, M., 2020. Climate change, global warming, and intensive care. Intensive Care Med. 46 (3), 485–487. https://doi.org/10.1007/s00134-019-05942-5.

Berg, P.O., Sevón, G., 2014. Food-branding places – a sensory perspective. Place Branding and Public Diplomacy 10 (4), 289–304. https://doi.org/10.1057/pb.2014.29.

Bschaden, A., Bopp, C., Rüdiger, A., Strobel, L., Stroebele-Benschop, N., 2024. Carbon footprints on the menu: exploring consumer choices and perceptions across real-world gastronomic settings. J. Clean. Prod. 463, 142773.

Budak, H.N., Özkaya, F., 2023. Isparta Gastronomi Kültüründe Etkili Faktörler Belirlenmesi *Sosyal Bilimlere Çok Yönlü Yaklaşımlar: Tarih, Turizm, Eğitim, Ekonomi, Siyaset Ve İletişim,* (s.315-326). Özgür Yayınevi.

Budak, H.N., Özkaya, F., 2024. *Isparta Özel Gün Gastronomisi* (2. Baskı). Isparta Uygulamalı Bilimler Üniversitesi Yayınevi.

Budak, N.H., Coşkun, S., Varol, M.B., Durlu-Özkaya, F., 2025. Carbon footprint assessment of Isparta spoon ceremony menu. Aydin Gastronomy 9 (1), 175–189.

Çekal, N., Doğan, E., 2022. The importance of standard recipe and geographical indications in sustainable gastronomy. J. Tour. 4 (1), 49–60. https://dergipark.org.tr/tr/pub/tucade/issue/71597/1075610.

Clune, S., Crossin, E., Verghese, K., 2017. Systematic review of greenhouse gas emissions for different fresh food categories. J. Clean. Prod. 140 (2), 766–783.

Córdova-Suárez, M., Córdova-Suárez, J., Teves, R., Barreno-Ávila, E., Silva-Frey, F., 2025. Life cycle assessment of Electro- submersible pump systems: carbon footprint mitigation using improved downhole technology. Energies 18, 2898. https://doi.org/10.3390/en18112898.

Coskun, S., Dogan, N.A., 2021. Determination of carbon footprint in textile industry. Süleyman Demirel University Journal of Natural and Applied Sciences 25 (1), 28–35. https://doi.org/10.19113/sdufenbed.670336.

Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F.N., Leip, A., 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. Nat. Food 2 (3), 198–209. https://doi.org/10.1038/s43016-021-00225-9.

Curtis, K.R., Cowee, M.W., 2009. Direct marketing local food to chefs: chef preferences and preceived obstacles. J. Food Distrib. Res. 40, 26–36.

Darius, L., 2023. Gastronomy tourism as a tool for the development of regions. Tourism & Heritage Journal 5, 100–119.

Dernini, S., 2019. Sustainable diets: a historical perspective. In: Ferranti, P., Berry, E.M., Anderson, J.R. (Eds.), Encyclopedia of Food Security and Sustainability. Elsevier, pp. 370–373. https://doi.org/10.1016/B978-0-08-100596-5.22075-1.

Dixit, K.S., 2021. Gastronomic tourism: a theoretical construct. In: Dixit, K.S. (Ed.), The Routledge Handbook of Gastronomic Tourism. Routledge, pp. 13–23.

Downie, J., Stubbs, W., 2012. Corporate carbon strategies and greenhouse gas emission assessments: the implications of scope 3 emission factor selection, bus. Strateg. Environ. Times 21 (6), 412–422.

Durlu-Özkaya, F., Varol, M.B., Coşkun, S., Budak, N.H., 2024. Ankara'nın coğrafi İşaretli yemeklerinin karbon ayak İzinin belirlenmesi. Ogusbd ·25 (3), 676–688. https://doi.org/10.17494/ogusbd.1541946.

Erdoğan, P., 2018. Determination of Greenhouse Gas Emission and Water Footprint of Turkish Cuisine. Thesis number: 522107. [Master Thesis, Nutrition and Dietetics, Hacettepe University]. Thesis Center Council of Higher Education, Türkiye.

European Commission, 2010. Europe 2020: a Strategy for Smart, Sustainable and Inclusive Growth. European Commission, Brussels, Belgium.

FAO, 2020. Greenhouse gas emissions from agrifood systems. Global, regional and country trends 2000–2020. https://openknowledge.fao.org/server/api/core/bitstreams/121cc613-3d0f-431c-b083-cc2031dd8826/content.

FAO, 2022. FAO publication catalogue. Italy, rome. https://doi.org/10.4060/cb9264enFroese.

Fooladi, E., Hopia, A., Lasa, D., Arboleya, J.C., 2019. Chefs and researchers: culinary practitioners' views on interaction between gastronomy and sciences. Int. J. Gastron. Food Sci. 15, 6–14. https://doi.org/10.1016/j.ijgfs.2018.11.003.
Gabrielli, P., Gazzani, M., Mazzotti, M., 2020. The role of carbon capture and utilization, carbon capture and storage, and biomass to enable a net-zero-CO2 emissions chemical industry. Ind. Eng. Chem. 59 (15), 7033–7045. https://pubs.acs.org/doi/10.1021/acs.iecr.9b06579?ref=pdf.
Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A., Tempio, G., 2013. Tackling climate change through livestock: a global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations. (Accessed 10 April 2024).
Giray, H., Kart, M.C.O., 2012. Economics of Rosa damascena in Isparta. Turkey Bulgarian J. Agric. Sci. 18 (5), 658–667.
Gössling, S., Garrod, B., Aall, C., Hille, J., Ve Peeters, P., 2011. Food management İn tourism: reducing tourism's carbon 'Foodprint'. Tour. Manag. 32 (3), 534–543.
Grosso, G., Mateo, A., Rangelov, N., Buzeti, T., Birt, C., Food, O.B.O.T., Association, N., 2020. Nutrition in the context of the sustainable development GoalsEur. J. Public Health 30 (1), 19–23. https://doi.org/10.1093/eurpub/ckaa034.
Guinée, J., 2001. Handbook on life cycle assessment—Operational guide to the ISO standards. Int. J. Life Cycle Assess. 6, 255.
Gün, S., Kılıç, G.D., 2023. Eko gastronomi ve sürdürülebilir gastronomi (Eco gastronomy and sustainable gastronomy). JOTAGS 10 (2), 999–1015. https://doi.org/10.21325/jotags.2022.1027.
Gussow, J.D., Clancy, K.L., 1986. Dietary guidelines for sustainability. J. Nutr. Educ. 18 (1), 1–5. https://doi.org/10.1016/S0022-3182(86)80255-2.
Hillel, D., Belhassen, Y., Shani, A., 2013. What makes a gastronomic destination attractive? Evidence from the Israeli negev. Tour. Manag. 36, 200–209.
Intergovernmental Panel on Climate Change (IPCC), 2014. Climate change 2014: synthesis report. Contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate chang. https://epic.awi.de/id/eprint/37530.
Isparta Governorship Provincial Directorate of Culture and Tourism, 2014. Isparta mutfağı "geleneksel tatlarımızdan seçmeler". Sistem Ofset 13 (1) syf 320.
Kaman, D., Bozkurt, Y., 2025. Sustainable development and the environment: strategies to shape the future. Dumlupınar Unıversity Journal of Social Sciences, E-ISSN: 2587-005X 83, 299–316. https://doi.org/10.51290/dpusbe.1581194, 2025.
Lenzen, M., Sun, Y.Y., Faturay, F., Ting, Y.P., Geschke, A., Malik, A., 2018. The carbon footprint of global tourism. Nat. Clim. Change 8 (6), 522–528. https://doi.org/10.1038/s41558-018-0141-x.
Lugo, J.M., Oliva, A.I., 2016. Thermal diffusivity and thermal conductivity of copper thin films at ambient conditions. J. Thermophys. Heat Tran. 30 (3), 1–9. https://doi.org/10.2514/1.T4727.
Manachi-Chatibura, D., Saayman, M., 2015. Local cuisine promotion: case study perspectives from key tourism stakeholders in Botswana. JOTAGS 3 (3), 50–61.
Mestre, R., La Rosa, J.d., Albeniz, I.M.d., Castillo, C.D.d, Baroni, M., Arboleya, J.C., 2022. Disciplinary interactions in gastronomy R&D teams. Int. J. Gastron. Food Sci. 30, 100609. https://doi.org/10.1016/j.ijgfs.2022.100609.
Minneci, R.P., Lass, E.A., Bunn, J.R., Choo, H., Rawn, C.J., 2020. Copper-based alloys for structural high-heat-flux applications: a review of development, properties, and performance of Cu-rich cu–cr–nb alloys. Int. Mater. Rev. 66 (6), 394–425. https://doi.org/10.1080/09506608.2020.1821485.
Mogensen, L., Hermansen, J.E., Trolle, E., 2020. The climate and nutritional impact of beef in different dietary patterns in Denmark. Foods 9 (9), 1176. https://doi.org/10.3390/foods9091176.
Omer, A.M., 2008. Energy, environment and sustainable development. Renew. Sustain. Energy Rev. 12 (9), 2265–2300.
Patel, J., 2006. Green sky thinking. Environ. Bus. 122, 32. https://www.researchgate.net/publication/296433180_Green_sky_thinking.
Pramezwarya, A., Ayuningsih, S.F., 2019. Sustainable gastronomy & shopping destination development in bandung City– West Java, Indonesia. Int. J. Innov. Creat. Chang. 5 (6), 1153–1163.
Presenza, A., Del, Chiappa G., 2013. Entrepreneurial strategies in leveraging food as a tourist resource: a cross-regional analysis in Italy? J. Herit. Tourism 8 (2), 182–192.
Risku-Norja, H., Kurppa, S., Helenius, J., 2009. Impact of consumers' diet choices on greenhouse gas emissions. Proceedings of the Conference "Future of the Consumer Society. Tampere, Finland, pp. 159–170.
Rodríguez, G.E., Arboleya, J.C., Prado, D., Munk, R., Valerón, N.R., 2023. Bioluminescence experience in the holistic cuisine: making contact through living light and sound. Int. J. Gastron. Food Sci. 31, 100641. https://doi.org/10.1016/j.ijgfs.2022.100641.
Scarpato, R., 2002. Sustainabile Gastronnomy as Tourist Product, Hjalager, M. Ve Richards, G. Toruism and Gastronomy. Routledge, New York, pp. 132–152.
Sgroi, F., 2023. Sustainability and culinary traditions? Understand the role of historical markets in the development of agri-food and local gastronomy from the perspective of behavioral economics. Int. J. Gastron. Food Sci. 34, 100809. https://doi.org/10.1016/j.ijgfs.2023.100809.
Spaargaren, G., Van Koppen, C.S.A., Janssen, A.M., Hendriksen, A., Kolfschoten, C.J., 2013. Consumer responses to the carbon labeling of food: a real life experiment in a canteen practice. Sociol. Rural. 53 (4), 432–453. https://doi.org/10.1111/soru.12016.
Sun, Y.-Y., Faturay, F., Lenzen, M., Gössling, S., Higham, J., 2024. Drivers of global tourism carbon emissions. Nat. Commun. 15, 54582. https://doi.org/10.1038/s41467-024-54582-7.
Taş Özdemir, V., 2020. Evaluation of the environmental impact of menus applied in a university dining hall. Master Thesis, Nutrition and Dietetics. Ankara University]. Thesis Center Council of Higher Education, Türkiye. Thesis number: 655180.
Thapa, P., Hasnine, M.D.T., Zoungrana, A., Thakur, S., Yuan, Q., 2022. Food waste treatments and the impact of composting on carbon footprint in Canada. Fermentation 8 (566), 1–10.
Turkish Patent and Trademark Office, 2024. Coğrafi işaret ve geleneksel ürün adı. https://www.turkpatent.gov.tr/cografi-isaretadresinden3Mayıs2024tarihindealınmıştır.
United Nations, 2015. Do you know all 17 SDGs? https://sdgs.un.org/goals. (Accessed 10 January 2024). Erişim Tarihi.
UNWTO, 2022. UNWTO/basque culinary center forum highlights gastronomy tourism as driver of rural development. https://www.unwto.org/news/unwto-bcc-forum-highlightsgastronomy-tourism-as-driver-of-rural-development.
Ural, E., 2023. Investigation of Nutritional Values of Traditional Elazığ Cuisine Meals and Determination of Carbon Footprint. Thesis number: 849014. [Master Thesis, Nutrition and Dietetics, Aydın Adnan Menderes University].Thesis Center Council of Higher Education, Türkiye.
Vermeulen, S.J., Campbell, B.M., Ingram, J.S.I., 2012. Climate change and food systems. Annu. Rev. Environ. 37 (1), 195–222. https://doi.org/10.1146/annurev-environ-042911-093704.
Wiedmann, T., Minx, J.C., 2008. A definition of 'Carbon Footprint'. In: Pertsova, C.C. (Ed.), Ecological Economics Research Trends'In İçinde. Nova Science Publishers, Hauppauge NY, USA, pp. 1–11. Chapter 1.
Willet, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Murray, C. J.L., 2019. Food in the anthropocene: the EAT–lancet commission on healthy diets from sustainable food systems. Lancet 393 (10170), 447–492. https://doi.org/10.1016/S0140-6736(18.