

Review

The Flavour of Sustainability: Mediterranean Aromatic Plants as Enablers of Nutrient-Dense and Low-Salt Gastronomy

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Abstract

Transitioning to sustainable, plant-forward diets, such as the Planetary Health Diet is a global priority; however, the palatability gap remains a formidable barrier, as consumers often perceive low-sodium, plant-centric diets as sensory-deficient. While aromatic herbs could bridge this gap, the current literature rarely integrates their sensory, ecological, phytochemical, and cultural dimensions. This narrative review explores how Mediterranean aromatic plants indigenous to the Maltese Islands function as sensory and molecular catalysts to bridge this gap. Through a thematic synthesis (2005–2026) integrating ethnobotanical evidence with molecular nutrition and sensory science, the Maltese archipelago is examined as a small-island ecological model. Chronic abiotic stressors, including high salinity and intense solar exposure, induce phytochemical priming, significantly enhancing secondary metabolites like polyphenols and terpenoids. These compounds establish a folk–medicine bridge, where traditional culinary practices align with modern biochemical validation. These bioactives demonstrate a capacity to modulate the NF-κB inflammatory axis, mitigate systemic inflammaging, and support the gut–microbiome–brain axis. Furthermore, these aromatics serve as translational tools for EAT–Lancet 2025 targets by facilitating cross-modal sensory compensation for sodium reduction and improving nutrient bioaccessibility via the culinary entourage effect. The TASTE–MED framework positions culinary nutrition as a vital translational bridge, asserting that flavour is a prerequisite for dietary sustainability and aligning individual molecular resilience with broader planetary health goals.

Keywords: Mediterranean dietary pattern; sensory literacy; abiotic stress; NF-κB signalling; salt reduction; culinary nutrition; Maltese cuisine



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1. Introduction

1.1. The Hippocratic Legacy: Food as Medicine in the Mediterranean

Aromatic botanicals, encompassing both leafy herbs and seed-based spices play a crucial role in shaping Mediterranean cultural identity, extending beyond their culinary applications to symbolise social traditions and shared heritage [1,2]. Within the Maltese Islands, aromatic herbs such as fennel (*Foeniculum vulgare*), thyme (*Thymus capitata*), rosemary (*Salvia rosmarinus*), marjoram (*Origanum majorana*), sage (*Salvia officinalis*), and mint (*Mentha* spp.) have long formed an integral part of local gastronomy [3,4]. These plants are

used not only to enhance flavour but also as medicinal remedies to support digestive health, preserve food, and provide subtle therapeutic effects [5,6]. Historically, Mediterranean societies did not separate food and medicine, reflecting the Hippocratic principle that food should function as medicine [7]. Over centuries, empirical knowledge about the medicinal properties of herbs became integrated into everyday cooking, producing culinary traditions where gastronomic enjoyment and physiological benefits coexist. However, to understand the application of these principles in a modern context, one must first examine the specific ethnobotanical evolution of the Maltese archipelago.

Scientific interest in functional foods and phytonutrients has renewed attention toward traditional herbal practices. Bioactive compounds found in aromatic plants including polyphenols, flavonoids, terpenes, and essential oils exhibit antioxidant, anti-inflammatory, antimicrobial, and metabolic regulatory activities [8,9]. These molecules interact with cellular signalling pathways, modulate gut microbiota, and influence immune responses [10].

1.2. The Low Impact Flavour Strategy

The global imperative to transition toward sustainable dietary systems has become a defining challenge of 21st-century public health, necessitating a shift toward plant-forward patterns that align human nutritional needs with planetary boundaries [11]. However, while the Mediterranean dietary pattern is a pre-eminent model for sustainable food systems and a gold standard for health [2], its global adoption is hindered by a complex array of structural and behavioural barriers, among which the perceived sensory limitations of plant-centric diets remain a significant hurdle [12]. These sensory barriers intersect with a broader disconnect between nutritional knowledge and everyday practice, as abstract dietary advice often fails to address the practicalities of meal preparation and flavour-building in daily life [13]. Culinary nutrition serves as a translational practice in this transition, recognizing that flavour is a prerequisite for dietary sustainability. Herbs and spices offer a low-carbon footprint solution for flavour enhancement, providing high sensory impact with minimal resource use compared to animal-derived fats.

While significant scientific attention, spanning observational epidemiology and controlled clinical trials, has focused on staples like olive oil, fruits, vegetables, and fish, the contribution of aromatic herbs and spices remains underestimated. This oversight persists despite their richness in bioactive compounds and their potential contribution to the diet's overall health effects [14]. Herbs and spices may therefore represent a 'missing link' in Mediterranean diet research, serving not only as functional bioactive ingredients but also as an aromatic toolkit that supports the sensory appeal and cultural sustainability of plant-forward eating patterns. Furthermore, many Mediterranean aromatics, particularly woody perennial herbs, are adapted to dry-land crops, representing a form of resource efficiency relevant to climate-resilient food systems. Promoting these low-impact flavour strategies may support the use of plants adapted to water-stressed environments, contributing to both ecological sustainability and the nutritional quality of the human diet. The urgency of such approaches is underscored by recent dietary trends; even in Malta, younger populations are shifting away from traditional staples such as legumes and vegetables toward more meat-centric, Westernized dietary patterns [15] and an increased reliance on ultra-processed foods, which frequently substitute nutrient dense aromatics with excessive sodium and artificial flavourings. By leveraging these cross-modal effects, nutrient-dense, under-consumed ingredients can be transformed into enjoyable, culturally meaningful meals that retain hedonic appeal.

1.3. Small-Island Ecology and Phytochemical Priming

The Maltese archipelago provides an especially interesting context for exploring this intersection due to its unique small-island ecology, exposing plants to chronic environmental stressors such as high salinity, strong sunlight, and limited freshwater availability [16]. Rather than stunting their utility, these stressors force indigenous plants to adapt by stimulating the production of higher concentrations of secondary metabolites, including phenolic compounds and essential oils. The result of this ecological stress is often an enhanced phytochemical density and more intense aromas, making Maltese herbs potent functional tools for the modern sustainable diet [17]. Crucially, the health-promoting potential of these stress-primed plants is intrinsically linked to culinary bioavailability and food synergy; the complex food matrix in which these herbs are prepared, such as their interaction with lipids or exposure to thermal processing, significantly dictates the liberation, absorption and systemic efficacy of their constituent polyphenols and essential oils [18,19].

1.4. Knowledge Gaps and Review Objectives

Despite the profound implications of this ecological–nutritional link, the current literature rarely integrates the sensory, ecological, phytochemical, and cultural dimensions of aromatic plants within a unified framework. While substantial research has investigated the Mediterranean diet as a whole, the specific contribution of aromatic herbs to dietary adherence, flavour perception, and ecological sustainability remains insufficiently synthesised. This gap is particularly evident in the Maltese archipelago. To date, very little research has examined native aromatic plants through an integrated lens that connects environmental adaptation to human health. Crucially, this lack of synthesis masks a major systemic problem within contemporary food systems and public health frameworks. While modern westernised diets face acute crises, regional aromatic flora remain fundamentally underutilised as functional solutions in current food systems that fail to leverage aromatics as scalable vehicles for health. Consequently, the role of these herbs within sustainable Mediterranean gastronomy remains insufficiently contextualised.

Therefore, this narrative review aims to synthesise evidence from ethnobotany, phytochemistry, nutritional science, and sustainability research to examine Maltese aromatic plants as functional components of climate-resilient food systems. Specifically, it explores the ecological, molecular, and translational pathways of Maltese aromatic plants, demonstrating how abiotic environmental stressors drive phytochemical density to enhance human cellular resilience. By examining the intersection of cultural identity, sensory literacy and sustainable dietary practices, this review highlights how traditional Maltese foodways integrate ecological adaptation with nutritional science to address the global demand for sustainable, health-promoting gastronomy.

2. Materials and Methods

This narrative review employs a qualitative synthesis of literature to explore the intersection of ethnobotany, food chemistry, and culinary nutrition within the Maltese context. The methodology focuses on integrating peer-reviewed evidence with localized research to establish the ‘folk–medicine bridge’, the space where historical foodways converge with modern molecular biology. By synthesizing the literature on the role of aromatic plants in a Mediterranean context, this review places particular emphasis on the synergy between cultural identity, sensory literacy, and sustainable dietary practices. This multidisciplinary approach utilizes the Maltese Islands as a strategic case study to investigate how small-island ecological stressors translate into molecular human health outcomes.

2.1. Search Strategy and Information Sources

The search strategy utilized a structured approach to the literature identification across major electronic databases, including PubMed, Scopus, and Google Scholar. To ensure the inclusion of localized data, the institutional repository of the University of Malta (OAR@UM) was utilized to access domestic peer-reviewed articles, academic dissertations, and technical reports. The search employed a combination of terms relating to Maltese ethnobotany, Mediterranean dietary patterns, herbal secondary metabolites, and sensory science. Priority was given to research centred on the Maltese archipelago to account for the impact of the island's unique abiotic stressors on herbal potency and phytochemical profiles.

2.2. Temporal Scope and Inclusion Criteria

The timeframe for this review was strategically bifurcated to reflect the dual focus on cultural heritage and modern biochemical science. No temporal limits were placed on the ethnobotanical and historical literature to ensure a longitudinal analysis of Maltese cultural continuity. Conversely, the selection of biochemical and clinical data prioritized research published between 2005 and 2026. This 21-year window captures a transformative era characterized by the formalization of culinary medicine, a paradigm shift toward metabolite bioavailability, and advancements in sensory science regarding cross-modal perception.

Inclusion was restricted to peer-reviewed journal articles, academic book chapters, and institutional research reports published in English or as translated historical records. The selection prioritized studies addressing the interaction between plant secondary metabolites and human health within the specific ecological and culinary context of the Central Mediterranean.

2.3. Analytical Framework

Following the collection of the literature, the gathered data were organized using a thematic narrative synthesis. This framework was used to integrate and compile contributions from a multidisciplinary review of the evidence, aligning diverse findings into a cohesive structure. The literature was categorized into five core dimensions: (1) ethnobotanical history and cultural continuity; (2) molecular and biochemical profiles of Maltese flora; (3) gut-microbiome and health interactions; (4) the role of aromatics in sensory compensation; and (5) the impact of culinary processing on gastronomic bioaccessibility. This approach allowed for the qualitative mapping of traditional empirical knowledge against modern biochemical data to characterize the functional role of Maltese aromatics.

3. The Maltese Culinary Landscape

3.1. Heritage, Climate, and the Evolution of Mediterranean Foodways

The Mediterranean dietary pattern is recognised by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) as an element of intangible cultural heritage, encompassing the skills, knowledge, rituals, and social practices related to food production, preparation, and consumption [1]. Foodways in Mediterranean societies have evolved through the dynamic interaction of geography, climate, and centuries of cultural exchange.

The region's Mediterranean climate, characterised by mild winters and hot, dry summers, supports the cultivation of staple crops such as olives, grapes, cereals, vegetables, and a diverse array of aromatic herbs. These locally adapted ingredients have historically formed the foundation of Mediterranean cuisines, shaping everyday cooking practices and broader dietary traditions across the region [20].

Archaeobotanical and historical evidence suggests that aromatic herbs including oregano, thyme, dill, coriander, mint, and fennel were already used during the Bronze Age in ancient Egyptian, Greek, and Roman cultures. These herbs were commonly added to foods, wines, oils, and sauces for flavour and digestive purposes, illustrating the long-

standing relationship between herbs and regional food traditions [21,22]. Today, herbs such as oregano, thyme, rosemary, and parsley remain defining elements of Mediterranean gastronomy, contributing not only to flavour but also to the preservation of traditional culinary identities across the region.

These herbs are not merely culinary additives but also sensory extensions of the landscape. The flavours associated with particular herbs often evoke a sense of place and belonging, linking dishes to specific landscapes and culinary traditions. For example, the widespread use of oregano and thyme in Southern European cooking reflects the ecological conditions of Mediterranean shrublands, where these plants thrive naturally. Similarly, fennel and bay leaves are frequently incorporated into soups, stews and fish dishes across Mediterranean countries, contributing to regional taste signatures that distinguish Mediterranean cuisine from other global culinary traditions.

Malta's central Mediterranean location has historically served as a crossroads for civilizations, including the Phoenicians, Romans, Arabs, Sicilians, and British, each leaving an indelible mark on the island's ethnobotanical heritage. This centuries-long cultural exchange has synthesized a unique culinary and medicinal identity, where endemic wild herbs coexist with flavours and practices introduced through colonial and trade networks [17]. Despite this diversity, the consistent presence of locally grown herbs contributes to a recognisable Maltese taste profile rooted in simplicity, seasonality, and plant-forward flavouring. Typical dishes including rabbit stew and fish soup known as *Aljotta* incorporate garlic, herbs and aromatic seasoning. The Maltese version of ratatouille—*Kapunata*—combines the use of basil, mint, and parsley to enhance the natural sweetness of summer vegetables such as eggplant and tomatoes. In *Hobż biż-Żejt*, a traditional Maltese bread-based meal, mint and parsley frequently accompany tomatoes, olive oil, tuna, and capers. The herbs elevate simple ingredients, exemplifying the Mediterranean culinary philosophy of maximizing flavour through plant-derived aromatics.

3.2. Sensory Signalling; The 'Folk–Medicine Bridge' in Practice

Historically, herbs were collected from the wild or cultivated in household gardens. Traditional Maltese remedies often included herbal infusions, poultices, and decoctions to treat digestive discomfort, respiratory ailments, wounds, and infections. Over time, medicinal plants became integrated into everyday meals [23].

This historical trajectory illustrates the 'folk–medicine bridge', where empirical culinary knowledge serves as a sensory precursor to modern biochemical validation. In this context, the distinct aromatic profiles of Mediterranean herbs are not merely aesthetic; they are the organoleptic indicators of specific therapeutic functions. For example, in fennel, long utilized in Maltese gastronomy to relieve digestive discomfort, the sweet, anise-like aroma is driven by anethole. In a culinary setting, this compound provides a cleansing flavour that cuts through the richness of fats; biochemically, these same molecules act as potent carminatives and antispasmodics [24], validating the traditional practice of serving fennel with heavier, protein-rich meals. Similarly, the sharp, pungent and slightly medicinal characteristic of thyme and oregano is a direct result of their high thymol and carvacrol content [25,26]. While these volatile oils define the savoury warmth of Maltese stews, they simultaneously function as the plant's chemical defence system, exhibiting antimicrobial and respiratory-clearing activities that align with their historical use in treating infections [24]. A comprehensive summary of these key Maltese aromatic plants, their primary bioactive constituents, and their dual culinary–medicinal functions is provided in Table 1. These examples highlight how traditional Mediterranean culinary and medicinal practices align with modern biochemical understanding. They utilise sensory-active molecules to achieve specific physiological outcomes, effectively blurring the line between the kitchen and the clinic.

Table 1. Phytochemical Profiles and Traditional Therapeutic - Culinary Applications of Key Maltese Aromatic Flora.

Common Name (Scientific Name)	Maltese Name	Major Phenolic Acids	Major Flavonoids	Major Essential Oil Constituents	Traditional Maltese Applications	Documented Biological Effects	Key References
Fennel (<i>Foeniculum vulgare</i>)	Bużbież	chlorogenic acid, caffeic acid, ferulic acid	quercetin, rutin	anethole, estragole, fenchone	Digestive teas, relief of bloating and colic, flavouring in baked goods like baked potatoes and a garnish for meat and fish dishes	carminative, antispasmodic, antioxidant	[24,27,28]
Mediterranean Thyme (<i>Thymus capitata</i>)	Sagħtar	rosmarinic acid, caffeic acid, ferulic acid	luteolin, apigenin	thymol, carvacrol, p-cymene, γ -terpinene	Herbal infusions for coughs, colds and respiratory ailments; culinary seasoning such as marinades	antimicrobial, antioxidant, anti-inflammatory, anti-cancer	[25,29]
Rosemary (<i>Salvia rosmarinus</i>)	Klin	rosmarinic acid, caffeic acid	luteolin, diosmin	camphor, 1,8-cineole, carnosic acid * carnosol * (* diterpenes found primarily in plant extracts)	Meat preservation, culinary seasoning on roasted meat, poultry and potatoes; also in marinades, soups, stews and bread, herbal tonics	antioxidant, neuroprotective, anti-inflammatory, anti-microbial, anti-fungal, anti-cancer, anti-diabetes	[30–33]
Sage (<i>Salvia officinalis</i>)	Salvja	rosmarinic acid	apigenin, luteolin	thujone, camphor, 1,8-cineole	Gargles and teas for sore throat and oral infections	anti-inflammatory, antimicrobial, antioxidant, antimutagenic, anti-dementia, anti-diabetes	[33,34]
Mint <i>Mentha</i> spp.	Nagħniegħ	rosmarinic acid	eriocitrin, luteolin	menthol, menthone	Digestive infusions; relief of stomach discomfort	antispasmodic, digestive, antimicrobial, anti-cancer, antineoplastic, antiviral, anti-histamine, anti-inflammatory, analgesic, against hypertension, urease inhibitory	[35]
Marjoram (<i>Origanum majorana</i>)	Merqtux	rosmarinic acid	apigenin, luteolin	terpinen-4-ol, sabinene hydrate	Culinary seasoning in soups, stews and salads, traditional herbal tea for digestive complaints	antimicrobial, antioxidant, anti-cancer, anti-inflammatory, antimutagenic, nephroprotective, hepatoprotective activities	[26,36]

Table 1. Cont.

Common Name (Scientific Name)	Maltese Name	Major Phenolic Acids	Major Flavonoids	Major Essential Oil Constituents	Traditional Maltese Applications	Documented Biological Effects	Key References
Oregano (<i>Origanum vulgare</i>)	Origanu	rosmarinic acid, caffeic acid	quercetin, luteolin	carvacrol, thymol, p-cymene, γ -terpinene	Food preservation, culinary seasoning, herbal remedies for colds	antioxidant, antimicrobial	[37,38]
Bay Leaf (<i>Laurus nobilis</i>)	Rand	caffeic acid derivatives	quercetin, kaempferol	1,8-cineole, sabinene, eugenol, linalool	Culinary seasoning added to broths, soups and stews; digestive aid	digestive support, antimicrobial, antioxidant	[39,40]
Parsley (<i>Petroselinum crispum</i>)	Tursin	chlorogenic acid	apigenin, luteolin	myristicin, apiol	garnishes, salads, traditional diuretic infusions	antioxidant, anti-inflammatory	[41]
Lemon Balm (<i>Melissa officinalis</i>)	Melissa	rosmarinic acid	quercetin, luteolin	citral, citronellal, geraniol	Calming teas, stress relief, sleep support	anxiolytic, antioxidant, antimicrobial	[42]
Chamomile (<i>Matricaria chamomilla</i>)	Kamomilla	caffeic acid, chlorogenic acid	apigenin, luteolin	bisabolol, chamazulene	Relaxing tea, digestive complaints, mild insomnia	anti-inflammatory, calming, antioxidant	[43,44]

4. Molecular Reality: Polyphenols and Cellular Pathways

4.1. Phytochemical Composition and Antioxidant Defence

Mediterranean aromatic herbs are characterized by a high concentration of polyphenols, flavonoids, and terpenoids, which serve as both sensory drivers and biological agents [45,46]. Key phenolic compounds, specifically rosmarinic acid, caffeic acid, ferulic acid, quercetin, and luteolin [27–30], act as potent antioxidants that scavenge reactive oxygen species, thereby preventing oxidative damage to cellular lipids, proteins and DNA [47]. Recent studies highlight their ability to regulate pathways associated with inflammation, oxidative stress, and metabolic disorders [48]. These compounds are particularly concentrated in Mediterranean flora due to the abiotic stressors of the region, which trigger the plant's secondary metabolite production as a defense mechanism.

4.2. Modulation of Inflammatory Pathways: The NF- κ B Axis and Inflammaging

Beyond general antioxidant activity, polyphenols interact with specific intracellular signalling pathways, most notably the Nuclear Factor kappa B (NF- κ B) pathway. Residing in the cytoplasm, NF- κ B translocates to the nucleus upon activation by inducible agents such as endotoxins and inflammatory stimuli, where it regulates the expression of over 400 genes central to the pathogenesis of respiratory diseases, diabetes, and cancer [49]. The modulation of this axis by phytochemicals like rosmarinic acid and quercetin offers a potent strategy to curb 'inflammaging', the chronic, low-grade inflammation underlying the aging process [49–51]. By inhibiting NF- κ B activation, these compounds curtail the production of pro-inflammatory markers such as TNF- α and IL-6 [50,52]. Furthermore, these phenolic classes regulate complementary Nrf2 and MAPK signalling pathways, which are critical in preventing pyroptosis, a form of inflammatory necrosis that can lead to DNA damage and malignant cell transformation [51]. Rather than merely treating symptoms, these phytochemicals build resilience at the cellular level, offering an enhanced health span by delaying the commencement of inflammaging pathogenesis. In the Maltese context, the daily consumption of these aromatics within the food matrix functions as a primary regulator of both innate and adaptive immune responses, transforming the Mediterranean diet into a proactive molecular intervention. This phenolic defence is further supported by the plant's volatile fraction; essential oils such as thymol and carvacrol provide complementary antimicrobial and acute anti-inflammatory effects, creating a multi-target approach to cellular health [24].

4.3. Microbiome Modulation and the Gut–Microbiome–Brain Axis

The functional significance of these aromatics extends to the gastrointestinal tract, where polyphenols act as prebiotic-like substrates. Rather than being fully absorbed in the upper digestive tract, these compounds reach the colon where they are metabolized by gut microbiota into short-chain fatty acids. These metabolites influence bacterial diversity, gut peptide synthesis, and nutrient absorption, thereby improving insulin sensitivity and intestinal integrity [49,52,53]. Parallel to these gut-level mechanisms, aromatic compounds influence appetite and satiety through complex olfactory–gustatory signalling. This sensory interaction, combined with the systemic effects of microbial metabolites, effectively links the Mediterranean plate to the gut–brain axis, regulating immunity, metabolism, and neurological signalling [8,10]. Consequently, traditional herbal infusions and herb-rich meals serve a dual purpose: facilitating immediate digestion and metabolic regulation while supporting long-term cognitive function [48].

5. Translational Gastronomy: Salt Reduction and Bioaccessibility

5.1. The Sensory Barrier in Sustainable Diets

The transition towards sustainable plant-forward dietary patterns is frequently framed in nutritional and environmental terms; however, sensory acceptance remains a critical limiting factor. Research consistently identifies sensory characteristics including taste as a primary driver of food choice—often outweighing health, cost and sustainability considerations [54–57]. Consumers consistently cite taste as the dominant determinant of food choice, often perceiving vegetables, legumes, and reduced-salt foods as lacking in sensory appeal. This ‘palatability gap’ represents not an inherent deficiency in plant-based foods, but a misalignment between learned taste preferences and the sensory profiles of sustainable diets. Consequently, foods perceived as less palatable, including many plant-based alternatives, are more likely to be deprioritized despite their established health and environmental benefits [57,58]. This challenge is further heightened by the well-documented health–taste trade-off, whereby foods perceived as healthy are often assumed to be less enjoyable, limiting their selection [59,60]. Sensory attributes such as flavour intensity, aroma, and texture are not only key predictors of food liking but also of actual intake [61,62].

5.2. Sensory Compensation and Sodium Reeducation

Aromatic herbs and spices emerge as powerful tools for facilitating both immediate and long-term acceptance of sustainable foods. Controlled trials demonstrate that seasoning vegetables, legumes, and low-salt foods with herbs and spices can maintain or increase liking, often allowing significant reductions in sodium without compromising hedonic appeal [63–65]. Beyond salt reduction, sensory studies indicate that aromatic plants can intensify taste perception itself. For instance, flavoured salts containing Mediterranean herbs were perceived as more intense yet equally pleasant despite containing less sodium, demonstrating that aromatic compounds can modulate fundamental taste perception [66]. Repeated exposure to seasoned foods supports hedonic adaptation, gradually recalibrating the palate toward plant-forward flavours [67]. Herbs and spices thereby act both through enhancing flavour and aroma to overcome initial resistance, and as learning aids, fostering the development of taste competence over time.

5.3. Culinary Chemistry and Bioaccessibility of Bioactives

The bioavailability of phenolic compounds strongly depends on their bioaccessibility, which can be defined as the fraction of phenolic compounds released from the food matrix in the gastro-intestinal tract [68]. Hence, the efficacy of the Mediterranean dietary pattern depends on the bioaccessibility of its phytochemicals, which is optimized through traditional cooking methods [69]. Mediterranean gastronomy utilizes specific techniques to ensure that bioactive compounds are released from the plant matrix and made available for absorption. Thermal disruption via slow-simmering stews breaks down rigid plant cell walls to release bound phenolic acids [70], while traditional infusions maximize the delivery of water-soluble antioxidants [71]. Furthermore, the foundational use of olive oil acts as a non-polar solvent that facilitates the lipid-phase solubilisation and absorption of fat-soluble essential oils such as thymol and carvacrol [72,73]. In the Maltese context, this is supported by the culinary practice of adding aromatics early in the cooking process to allow for maximum diffusion of volatile compounds into the food matrix [72].

5.4. The TASTE-MED Model

Emerging research in sensory science and food education suggests that the palatability gap can be addressed through palate education and strategic flavour enhancement,

particularly via herbs, spices and culinary techniques such as roasting, caramelising and seasoning. Frameworks such as Teaching Taste: The TASTE-MED model conceptualize taste competence as a learnable, multisensory capacity developed through guided sensory experiences, reflection, and culturally embedded food practices, providing a theoretical basis for sensory-focused interventions in sustainable eating behaviour [74].

From a gastronomic perspective, research on Mediterranean gastronomy further highlights that plant-forward diets are deeply rooted in Mediterranean culinary traditions, where herbs, spices, garlic, and aromatic vegetables are central to the region's flavour diversity and sensory identity, contributing to both enjoyment and dietary adherence [19]. These practices challenge the perception that plant-forward diets are inherently bland, showing instead that they can be rich, varied, and satisfying. Herbs and spices enhance aroma, modulate taste perception, and increase overall food enjoyment, supporting both acceptance and long-term adherence to sustainable dietary patterns. Educating the palate, therefore, is inseparable from culinary practice, involving repeated exposure, mindful tasting, and the skilled use of flavour-building techniques.

6. From Planetary Policy to Local Food Systems

The global transition toward sustainable food systems represents an urgent public health mandate to align human nutrition with planetary boundaries. The EAT-Lancet Commission identifies food systems as the primary driver of breached safe operating spaces, specifically affecting land-system change and biosphere integrity [75]. To feed 10 billion people by 2050 within planet boundaries, the Commission advocates for an urgent, just transition to plant-rich diets, potentially preventing 15 million avoidable deaths annually [76]. Central to this is the Planetary Health Diet, a flexible flexitarian framework emphasizing plant-based foods to optimize health across diverse global contexts [77]. Operationalizing this framework requires restructuring local food systems to emphasize nutrient density and environmental sustainability.

Within this global paradigm, the Mediterranean dietary pattern serves as a preeminent illustration of how such a transition can be operationalised in culturally meaningful ways [78]. It embodies the principle of 'food synergy' where the health-promoting effects of a diet arise from the reciprocal interaction of its components rather than the sum of isolated nutrients [79]. Under this holistic framework, no single food or bioactive compound can be decoupled from the broader dietary matrix; instead, the benefits are emergent properties of the entire pattern [80]. These synergistic pathways are traditionally systematised into metabolic pillars: lipid-lowering and modulating effects; anti-inflammatory, anti-oxidative, and anti-aggregating activities; and the modulation of signalling pathways involved in the development of metabolic diseases and cancer [81].

Achieving such high-level targets requires the strategic revitalisation of underutilised crops to enhance food system resilience [82]. Legumes, specifically, are identified as foundational examples of high-quality protein within this sustainable model, featuring high concentrations of lysine and arginine that effectively complement cereal-based diets to achieve amino acid completeness [83]. Viewed through a clinical nutrition lens, this reintroduction of legumes within food practices addresses the need for increased intake of dietary fibre as well as the micronutrient deficiencies, namely iron, zinc, and folate [84,85] characteristic of modern westernised diets. In addition, shifting from animal-based proteins to pulses can mitigate climate change by reducing greenhouse gas emissions and improving soil fertility through natural nitrogen fixation [86].

Crucially, this review highlights that Mediterranean aromatic plants are not merely culinary additives but are nutritionally primed by the very environmental challenges that they face. This link between small-island ecology and phytochemical density suggests

that the harsh climate of the Maltese Islands serves as a catalyst for human molecular resilience, positioning unique regional flora as vital assets in a climate-resilient food system. The successful integration of these plant-based foods into everyday diets depends not only on their nutritional value, but on how they are prepared, perceived, and experienced. Culinary nutrition therefore functions as a critical translational bridge between nutritional ‘knowing’ and gastronomic ‘doing’ [13]. While legumes contain anti-nutritional factors such as phytates and tannins, these can be effectively reduced through traditional techniques such as soaking, fermentation, and controlled thermal processing [82], enhancing nutrient bioaccessibility without compromising cultural integrity. More importantly, these culinary practices shape flavour, texture, and overall palatability, key determinants of long-term dietary adherence.

In this context, flavour emerges as a central, yet often underexplored, driver of dietary behaviour. Aromatic herbs, integral to Mediterranean food culture, exemplify this role as the ‘flavour of sustainability’. Beyond enhancing palatability, their rich polyphenol profiles contribute to cardio metabolic health and interact with the microbiome–gut–brain axis, influencing appetite regulation and food preferences. By enabling reduced reliance on sodium and increasing the acceptability of plant-forward meals, herbs act as both sensory and functional mediators of dietary change, an approach that validates the Hippocratic principle: food as medicine. Ultimately, acknowledging flavour as a functional driver allows for a more holistic, consumer-accepted transformation of contemporary food systems.

7. Conclusions and Future Directions

As synthesised in the conceptual framework (Figure 1), sensory literacy, culinary practices, plant-based foods, and microbiome-mediated feedback operate as an interconnected system linking dietary patterns to long-term health and sustainability outcomes. This model illustrates how flavour-driven pathways can reinforce healthier food choices, supporting both individual metabolic resilience and broader planetary health. However, the successful translation of these benefits into population-level outcomes will require supportive policy environments and food system innovations. Public health strategies should move beyond nutrient-focused messaging to incorporate culinary education that promotes the use of traditional Mediterranean herbs as flavour-enhancing alternatives to salt and highly processed seasonings. Public health initiatives could educate populations on the use of local herbs to prepare flavourful vegetables, legumes and fish-based dishes to improve adherence to Mediterranean dietary patterns, particularly among younger generations. School food programmes should integrate nutrition education, culinary skills and school gardening activities that encourage students to cultivate and use traditional aromatic herbs. Such experiential learning approaches may improve food literacy, increase familiarity with plant-based foods, preserve Maltese culinary heritage and support lifelong healthy eating behaviours. Likewise, food manufacturers, caterers and the hospitality sector should be encouraged to utilise locally grown aromatic plants in product reformulation and menu development, supporting healthier food choices while strengthening regional food identity.

Future research should move beyond phytochemical characterisation towards translational and systems-based investigations. Priority areas include evaluating the effectiveness of herb-based sodium reduction strategies, examining the long-term influence of aromatic plants on dietary adherence and food choice behaviour, investigating the impact of traditional Mediterranean cooking methods on phytochemical bioavailability, and characterising interactions between locally grown herbs and the gut microbiome. Furthermore, Malta offers a unique opportunity to examine how environmental stressors such as salinity, drought and solar exposure influence phytochemical accumulation and whether these ecological adaptations translate into measurable sensory and health advantages. Crucially, research

must transition to localisation as no in vivo studies currently evaluate the metabolic and physiological effects of aromatic crops grown directly on Maltese soil.

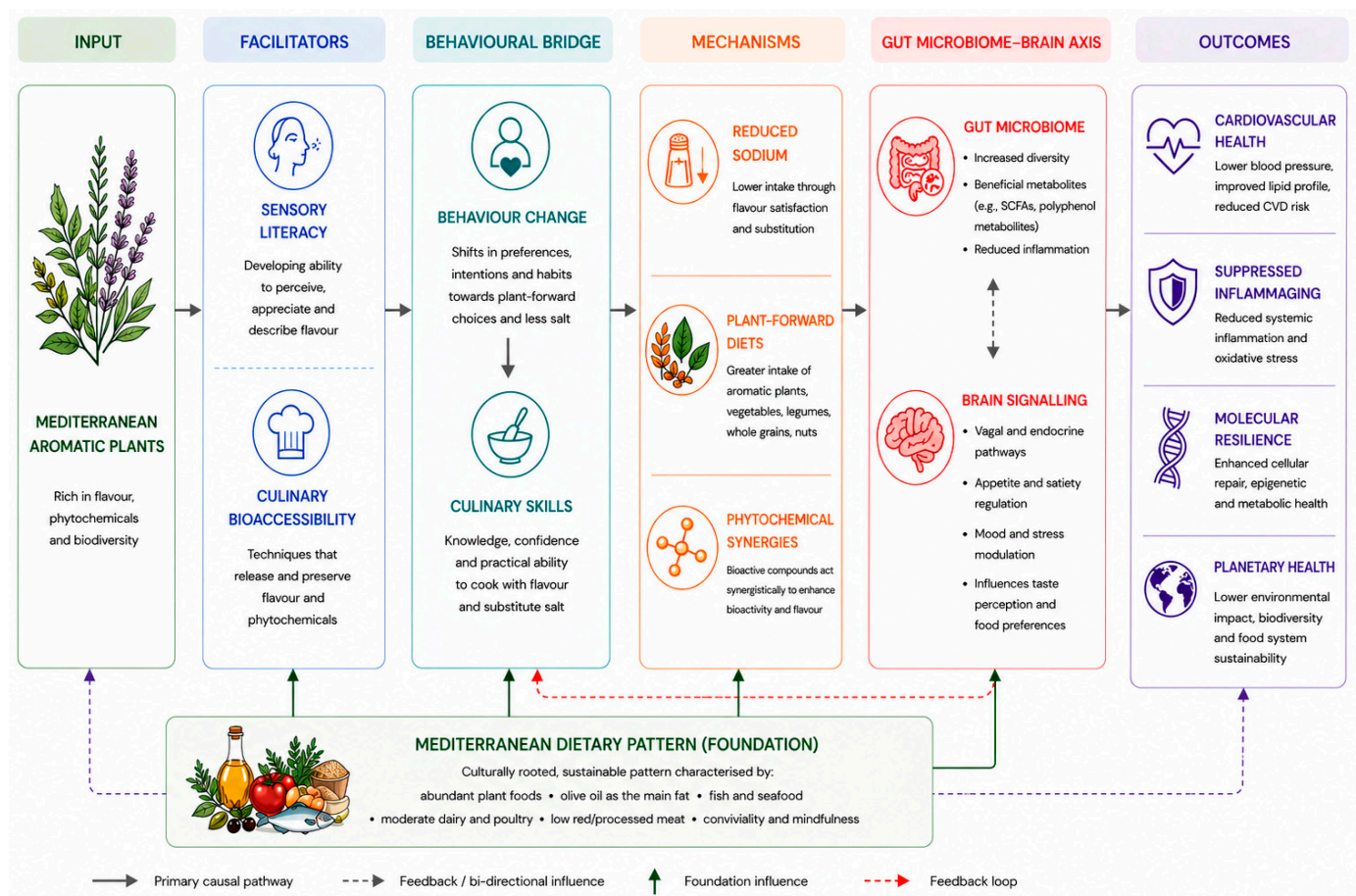


Figure 1. Conceptual framework linking Mediterranean aromatic plants, sensory-driven behaviour change, and health outcomes through microbiome-brain pathways.

By revitalising underutilised, climate-resilient aromatic crops, Mediterranean countries have an opportunity to develop a contemporary flavour strategy that simultaneously advances public health, environmental sustainability and cultural heritage preservation. In this regard, aromatic herbs may represent a previously overlooked pillar of the Mediterranean diet, linking ecological resilience, culinary enjoyment and human health in a manner that is both scientifically compelling and practically actionable.

Mediterranean aromatic plants provide flavour and phytochemicals that, through sensory literacy and culinary bioaccessibility, support behaviour change and culinary skills. These enable reduced sodium intake and adoption of plant-forward diets, with synergistic phytochemical effects. Dietary changes modulate the gut microbiome and brain signalling, influencing appetite, sensory perception, and food preferences. These interconnected pathways contribute to improved cardiovascular health, reduced inflammaging, enhanced molecular resilience, and planetary health. Solid arrows indicate primary pathways; dashed arrows represent feedback mechanisms.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/gastronomy4030013/s1>.

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Abbreviations

The following abbreviations are used in this manuscript:

NF-κB	Nuclear Factor kappa B
TNF-α	Tumor Necrosis Factor-alpha
IL-6	Interleukin-6
Nrf2	Nuclear factor erythroid 2-related factor 2
MAPK	Mitogen-Activated Protein Kinase

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