DEVELOPMENT OF FOOD FLAVOR PERCEPTİON IN GASTRONOMY: A BİBLİOMETRİC STUDY ON NEUROGASTRONOMY

Gastronomide Gıda Lezzet Algısının Gelişimi: Nörogastronomi Üzerine Bibliometrik Bir Çalışma

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Abstract

This research focuses on the perception and experience of food by analyzing the literature in the field of neurogastronomy from a bibliometric perspective. The study aims to determine the extent of interest in neurogastronomy and the current state of scientific studies in this field by examining academic research conducted at national and international level between 2006 and 2024. In this direction, document review method was used and 14 articles, 2 theses and 3 books were reached as a result of searches based on the keyword "neurogastronomy". Bibliometric analysis techniques were applied on the data obtained. Contributions from disciplines such as neurology, nutrition science, psychology, food science and technology offer a more comprehensive understanding of eating behaviors, food perception and dietary preferences. These interdisciplinary approaches increase the scientific and practical potential of neurogastronomy, enabling the development of innovative solutions for individuals' quality of life. This research focuses on food perception and experience by analyzing the literature in the field of neurogastronomy from a bibliometric perspective. The study aims to determine the extent of interest in neurogastronomy and the current state of scientific studies in this field by examining academic research conducted at national and international level between 2006 and 2024. In this direction, document analysis method was used and 14 articles, 2 theses and 3 books were reached as a result of the searches based on the keyword "neurogastronomy". Bibliometric analysis techniques were applied on the data obtained. Contributions from disciplines such as neurology, nutrition science, psychology, food science and technology provide a more comprehensive understanding of eating behaviors, food perception and dietary preferences. These interdisciplinary approaches increase the scientific and practical potential of neurogastronomy, enabling the development of innovative solutions for individuals' quality of life.

Key words: Gastronomy, Neurogastronomy, Sensory Analysis, Food Consumption, Business.

Öz

Bu araştırma, nörogastronomi alanındaki literatürü bibliyometrik bir perspektiften ele alarak, gıda algısı ve deneyimine odaklanmaktadır. Çalışma, 2006-2024 yılları arasında ulusal ve uluslararası düzeyde gerçekleştirilen akademik araştırmaları inceleyerek, nörogastronomiye olan ilginin boyutlarını ve bu alandaki bilimsel çalışmaların mevcut durumunu belirlemeyi hedeflemektedir. Bu doğrultuda, doküman inceleme yöntemi kullanılmış ve "nörogastronomi" anahtar kelimesi temel alınarak yapılan aramalar sonucunda 14 makale, 2 tez ve 3 kitaba ulaşılmıştır. Elde edilen veriler üzerinde bibliyometrik analiz teknikleri uygulanmıştır. Nöroloji, beslenme bilimi, psikoloji, gıda bilimi ve teknoloji gibi disiplinlerden gelen katkılar, yeme davranışları, gıda algısı ve diyet tercihleri üzerine daha kapsamlı bir anlayış sunmaktadır. Bu disiplinler arası yaklaşımlar, nörogastronominin bilimsel ve pratik potansiyelini artırarak bireylerin yaşam kalitesine yönelik yenilikçi çözümler geliştirilmesine olanak tanımaktadır. Bu çalışma, nörogastronomi alanındaki bilimsel araştırmaların artan önemini ve bu alandaki çalışmaların hem akademik hem de pratik uygulamalar açısından sunduğu potansiyeli ele almaktadır. Özellikle 2020 yılından itibaren çalışmaların sayısında belirgin bir artış gözlemlenmiş olup, nörogastronomi kavramının yeniliği bu sınırlı sayıdaki araştırmaları daha da değerli kılmaktadır. Elde edilen bulgular, nörogastronomik yaklaşımların gıda endüstrisi, restoran yönetimi ve sağlık sektörü gibi alanlarda yenilikçi çözümler sunduğunu ortaya koymaktadır. İşletmeler için bu bilgiler, müşteri deneyimlerini özelleştirme, tat profillerini geliştirme ve pazarlama stratejilerini güçlendirme yoluyla rekabet avantajı oluşturma fırsatı sunmaktadır. Nörogastronomi alanında yapılan çalışmalar, tat algısı, duyusal etkileşimler ve çevresel faktörlerin insan karar alma süreçlerindeki etkisini anlamada önemli ilerlemeler sağlamıştır. Bibliyometrik analiz sonuçları, özellikle 2006-2024 yılları arasında bu alana olan ilginin giderek arttığını ortaya koymaktadır. Literatür, nörogastronominin gıda endüstrisi, restoran yönetimi ve sağlık sektörü gibi alanlarda geniş bir uygulama potansiyeline sahip olduğunu göstermektedir. Nörogastronomi alanındaki gelecekteki araştırmaların, insan sağlığı ve yaşam kalitesine yönelik olumlu katkılar sunması beklenmektedir.

Anahtar Kelimeler: Gastronomi, Nörogastronomi, Duyusal Analiz, Gıda Tüketimi, İşletme.

Introductıon

This study aims to provide a comprehensive examination of the field of neurogastronomy through a bibliometric analysis of national and international academic literature published between 2006 and 2024. Neurogastronomy, which emerged as a scientific discipline in the early 21st century, investigates how multiple sensory inputs—including visual, olfactory, auditory, textural, gustatory, and thermal stimuli—are processed in the brain and how they collectively shape the perception of flavor and the overall food experience (Herz, 2016; Shepherd, 2012). The study adopts a multidimensional perspective on food perception and experience, highlighting that individual preferences and emotional responses to food are influenced not only by taste but also by contextual factors such as food presentation, design, ambiance, and sensory

congruency (Cankül and Uslu, 2020). In this context, the aim is to identify the intellectual structure, thematic evolution, and research dynamics within the field of neurogastronomy by analyzing scientific publications, theses, and scholarly contributions. By mapping the development and dissemination of neurogastronomic knowledge, the study also seeks to underscore its growing relevance in applied fields such as gastronomy, restaurant management, and health sciences. As emphasized in recent studies, neurogastronomy holds potential for improving public health and enhancing quality of life by fostering a deeper understanding of human food choices and sensory behavior (Dülgaroğlu, 2023; Herz, 2016). The findings are expected to contribute both to theoretical enrichment and to the expansion of practical applications within food-related disciplines.

Conceptual Framework

Gastronomic richness not only contributes to the local economy, but is also of great importance in terms of preserving cultural heritage, promoting entrepreneurial activities and promoting the region.

Gastronomy and the Concept of Neurogastronomy

Meeting the need for nutrition, which has been a basic requirement for human existence since time immemorial, constitutes an intrinsic aspect of daily life (Shepherd, 2012). This action takes place in a cycle that repeats every day. Over time, this cycle has evolved in different dimensions until today, resulting in a variety of eating habits and styles. The food and beverage industry is in a constant quest to influence individuals' sensitivity and desire for flavors and taste perceptions (Cankül and Uslu, 2020). The act of eating is an integral part of our daily lives and is one of the basic needs of human beings. The study of our eating habits and preferences has led scientists to understand the complex processes underlying our drive to eat. As Shepherd (2012) points out, this process is largely controlled by hormones, which are activated during hunger and satiety and form the basis of our eating habits.

Human beings share a multifaceted relationship with food, encompassing dimensions such as sustenance, livelihood, and emotional gratification for individuals. This intricate connection may, in certain instances, lead to consequences such as the obesity epidemic, highlighting the nuanced nature of this association (Dülgaroğlu, 2023). Neurogastronomy, as a relatively recent discipline, delves into the examination of this complex relationship, bridging various fields including basic science, nutrition, psychology, agriculture, food science, and health (Rhind and Law, 2018).

The term "Neurogastronomy" was coined and introduced in 2006 by Gordon M. Shepherd, a professor of neurobiology at Yale School of Medicine. Shepherd first utilized the term in 2006, recognizing the pivotal role of odors in shaping certain tastes. During the same year, Shepherd authored an article in the journal Nature, delving into topics such as the molecular biology of smell, odor receptors, the biochemistry of food preparation, and their processing by the brain. This publication elucidated the fundamental principles of neurogastronomy and outlined the key focal points of the

field. In this context, neurogastronomy adopts an interdisciplinary approach to the perception and consumption of food, facilitating a more comprehensive understanding of behaviors and preferences related to food (Tokat and Yılmaz, 2023).

Neurogastronomy emerges as a nascent field that amalgamates various research endeavors to forge connections between gastronomy and neurology. The intricate relationship between neurogastronomy and gastronomy provides a nuanced and multifaceted framework for delving deeper into our engagement with food. This relatively new discipline seamlessly integrates elements of neuroscience, psychology, and gastronomy, seeking to unravel the intricacies surrounding the experience and enjoyment of food. At its core, neurogastronomy explores the intricate interactions between the brain and food. It delves into the ways individuals perceive taste, smell, and other sensory experiences, aiming to decipher the profound effects of these perceptions on food preferences. Through this interdisciplinary lens, neurogastronomy endeavors to enrich our comprehension of the complex interplay between neurological processes and the enjoyment of gastronomic experiences (Rolls, 2016). Gastronomy has historically been regarded as a symbol of wealth, prosperity, and social status across civilizations. Beyond its basic function of nourishment, food has played a pivotal role in the advancement of human civilization and the shaping of societal structures. Throughout history, food culture has not only satisfied biological needs but also served as a medium through which individuals express identity, structure social life, and foster communal cohesion (Sağır, 2012).

The field of gastronomy services operates in an intensely competitive environment that requires market players to constantly strive to offer new and innovative elements. Increasing customer satisfaction and enhancing the experience is a critical factor to stand out in this competitive environment (Yılmaz and Sezgin, 2022). Customer expectations are shaped from the moment a food order is placed in a catering establishment. However, the critical stage that determines customer satisfaction is the moment the food is served. At this point, individuals use all their senses to make an internal evaluation of the food or the restaurant in general. The appearance and arrangement of the food on the plate is an important determinant of this evaluation (Özata Şahin, 2020).

Vision is one of the primary senses that customers use to evaluate food. Visual perception, the aesthetics of the presentation, the arrangement and color harmony on the plate are all factors that create a first impression in the customer. This is where the sense of smell comes into play, and according to one of the early theories, the way a particular food is served and arranged can first influence the brain through vision and then modulate the overall consumption experience by influencing the sense of taste. The influence of people's visual perception on the taste experience is based on its relationship with the perception of beauty. In this context, food on an aesthetically arranged plate tends to be perceived as more satisfying in terms of taste compared to guests who receive the same food with an intrinsically unattractive arrangement. Visual and olfactory (the sensory system used for the sense of smell) interactions shape the holistic perception of the dining experience; therefore, aesthetic elements and scents play a critical role in enhancing customers' dining experience (Berˇcík et al., 2021). In addition to how gastronomy products are perceived and evaluated by consumers, their preparation

processes constitute an important area of research. In this context, neurogastronomy aims to gain an in-depth understanding of the effects of food on consumers by addressing both the preparation and consumption stages of food. This discipline bridges gastronomy and neuroscience in a scientific endeavor to explore the deeper layers of the food experience (Erçetin and Güneş, 2022).

Neurogastronomy aims to uncover misleading interactions in food consumption by analyzing brain processes. Research in this field aims to understand the complex relationships of how the five senses work together. The act of eating is not only a physical need, but also a sensory and cognitive experience. This experience is shaped by an individual's perceptions, appetite and even preferences (Tokat and Yılmaz, 2023).

Neurogastronomy, as articulated by Shepherd (2012), is dedicated to unraveling the intricate mechanisms within the brain that govern the what, how, and why of our eating behaviors. This discipline intricately investigates the collaborative functioning of the five senses, the process of eating itself, and the formation of abstract concepts such as appetite. Shepherd's perspective underscores the endeavor to comprehend the complex neural processes underlying our interactions with food, shedding light on the multifaceted aspects of the sensory and cognitive dimensions involved in the act of eating (Yurt and Bayraklı, 2022). Neurogastronomy goes beyond the mere preparation process of gastronomic products; it also delves into the intricate realm of how these products are perceived and evaluated by consumers. This field of study seeks to understand the cognitive and sensory aspects that contribute to the overall experience and appraisal of gastronomic offerings, providing insights into the subjective dimensions of taste, aroma, and other sensory elements that shape individuals' perceptions of food (Cankül and Uslu, 2020).

Neurogastronomy endeavors to elucidate intricate interactions in food consumption by scrutinizing brain processes. Research within this domain seeks to fathom the intricate relationships inherent in the combined functionality of the five sensory organs. Eating, beyond being a physiological necessity, constitutes a sensory and cognitive experience, molded by individual perceptions, appetites, and preferences (Shepherd, 2012). Within the purview of neurogastronomy lies the study of the intricate physiology of taste, commencing in the mouth and culminating in the brain. Chewing initiates the perception of food through the action of salivary enzymes and taste buds. Papillae house receptor cells capable of discerning fundamental aromas such as bitter, sweet, salty, sour, and umami, with the recently identified starch taste also assuming significance (Şengül and Adabalı, 2023). This complex discipline necessitates collaboration among chefs, anthropologists, neuroscientists, and other expert cohorts. It underscores the pivotal role of chefs in enhancing the dining experience and spans diverse domains including nutrition, health, business strategies, and customer service by exploring the impacts of foods on the brain. The act of eating extends beyond mere bodily nourishment, carrying an emotional weight; this emotional context has the potential to engender positive memories or encapsulate negative experiences (Santos, 2019).

The core proposition of neurogastronomy underscores that taste perception is governed by the brain rather than the physical properties of food. This theory embraces a multisensory approach, extending beyond taste and smell to encompass all senses and movements (Dieguez, 2013). As articulated by Brillat-Savarin, the principle that "Taste is not given passively" signifies that the gastronomic experience is shaped not merely by food consumption but also by sensory interactions, including the use of utensils, the mouth, and various other sensory engagements (Brillat-Savarin, 1825). The presence of flavor in the brain is explicable through neurogastronomy, integrating biological, emotional, and cultural elements. Information acquired through the five senses is consolidated in the brain and processed in corresponding regions, elucidating the complex interconnection between sensory input and cognitive functions in the flavor experience (Tokat and Yılmaz, 2023).

Gordon Shepherd (2012) highlights that the perception of taste creates "odor images" in the brain, much like visual images facilitate facial recognition and imagining locations. The text underscores that neurological damage, along with clinical examples illustrating its impact on language and memory, may lead to changes in food behaviors. It emphasizes the potential role of unknown brain damage in this process. Gardon Shepherd (2012) draws attention to the psychological basis of flavor perception in his book and states that the taste impression formed in the mouth is actually a result of retronasal olfaction in the nasal cavities. Volatile aromatic compounds released in the mouth after chewing are redirected to the nasal cavity during exhalation and detected by olfactory neurons. This subconscious process indicates a role in shaping the taste of foods, emphasizing the significance of smell in flavor perception. In this context, as highlighted by Dieguez (2022), olfactory perception is intricately linked to a complex anatomical and sensory process extending to the olfactory bulb in the brain.

Importance of Nerogastronomy in Food and Beverage Businesses

In the business world, neurogastronomy is a discipline that focuses on understanding individuals' perceptual, emotional and behavioral responses to food and beverages. This field offers strategic advantages to businesses by examining the factors that shape consumers' taste experiences. Neurogastronomy, which investigates how sensory elements such as taste, smell, texture and presentation are perceived and how these perceptions are reflected in consumer behavior, contributes to the development of innovative approaches in critical areas such as product development, marketing strategies and customer relationship management in the food and beverage industry (Lahne, 2013). The potential contributions of neurogastronomy to businesses are as follows (Rhind Rhind and Law, 2018);

-Impact on customer experience

-Developing a flavor profile

- Menu Planning and Pricing

-Marketing and branding

-Health and nutrition awareness

-Innovation and creativity

Neurogastronomy is a discipline that encourages innovation in the food and beverage industry and offers significant contributions to businesses (Yıldız and Yılmaz, 2020). The topics discussed in this text highlight the opportunities it offers for businesses to improve customer experience, enhance taste profiles, provide strategic guidance in menu design and pricing, strengthen marketing and branding activities, increase health and nutrition awareness, and encourage innovation and creativity (Dieguez, 2013).

In terms of improving the customer experience, neurogastronomy allows businesses to optimize the taste profiles, presentation techniques and aesthetic details of food and beverages. This can be an important way to increase customer satisfaction, build a loyal customer base and gain a competitive advantage in the market. Improving taste profiles guides businesses to better organize their product range and create flavors that meet their customers' expectations. Furthermore, neurogastronomy provides strategic guidance in menu planning and pricing to create more attractive and profitable menus.

In the context of marketing and branding, neurogastronomy offers businesses the opportunity to develop carefully crafted strategies to promote their products and strengthen their brands (Özata Şahin, 2020). With this approach, businesses can strengthen their brand image as well as establish an emotional connection with consumers. By building visual, taste and smell perceptions on a scientific basis, they can offer customers a more impressive experience. In terms of health and nutrition, neurogastronomy enables businesses to develop healthier and more nutritious products. It also contributes to increasing consumers' awareness of healthy nutrition (Uçuk, 2022).

In terms of creativity and innovation, neurogastronomy guides businesses in product development processes and supports them to make a difference in the sector and offer unique experiences to their customers (Dieguez, 2013). When all these features come together, neurogastronomy becomes a multidimensional tool for food and beverage businesses. It both increases customer satisfaction and provides businesses with a competitive advantage. Therefore, neurogastronomy is becoming increasingly important in the food and beverage sector and is considered as a strategic approach for businesses (Rhind and Cooking, 2018).

Methodology

This study employs a bibliometric analysis approach to examine the academic literature on neurogastronomy. The methodology was designed to systematically review and analyze the existing research using bibliographic review and documentary review methods. The primary aim is to assess the extent of scholarly interest in neurogastronomy and map the development of research in this field.

Data Collection Process

The bibliometric data were collected through searches in Google Scholar, Web of Science, and YÖK Thesis Databases between December 2023 and February 2024. Due to the novelty of the term "neurogastronomy," the number of academic studies was found to be limited. The search was conducted using the keyword "neurogastronomy", without

incorporating synonyms or broader terms, to maintain focus on the specific subject matter.

Inclusion and Exclusion Criteria

To ensure the relevancy and quality of the dataset, the following criteria were applied:

• Inclusion Criteria:

• Studies published between 2006 and 2024.

• Peer-reviewed journal articles, theses, and books.

• Research directly related to neurogastronomy, including its theoretical framework and applications.

• Exclusion Criteria:

• Conference papers and abstracts were not considered.

• Studies that mentioned neurogastronomy but did not focus on its core aspects were excluded.

Bibliometric Data and Analysis Process

The final dataset consisted of 14 journal articles, 2 theses, and 3 books, totaling 19 academic sources. Based on this limited dataset, a descriptive bibliometric analysis was conducted. The analyses included publication year distribution, type of publication (article, thesis, book), page count ranges, author-based contributions, and classification of research objectives. Due to the relatively small number of sources, advanced bibliometric techniques such as citation analysis and keyword frequency analysis were not applied. However, thematic evaluations were carried out based on the subject focus and interdisciplinary context of the studies.

Data Sources and Justification

• Google Scholar, Web of Science, and YÖK Thesis Databases were chosen as primary sources due to their extensive coverage of academic literature.

• Google Scholar is widely recognized as a reliable academic resource (Çakmak, 2024) and provides access to a broad range of studies.

• YÖK Thesis Databases is a key repository for graduate and doctoral theses in Türkiye, offering valuable insights into academic research trends (Tokat and Yılmaz, 2023).

• Web of Science is known for its bibliometric capabilities, enabling researchers to analyze scientific impact and research trends (Mongeon and Paul-Hus, 2016).

Limitations and Need for Further Research

The relatively small number of studies identified highlights the limited academic engagement with neurogastronomy to date. While the dataset provides an initial framework for understanding the field's development, a broader dataset is required for more extensive content analysis and generalization of findings. Future research should aim to expand the bibliometric parameters and integrate interdisciplinary perspectives

to offer a more comprehensive understanding of neurogastronomy's impact on food science, psychology, and consumer behavior.

Findings

Information about the authors, year of publication, research objectives, type and number of pages of the bibliographically analyzed studies will be shown in Table 1 in detail.

Table 1: Information on Authors, Publication Year, Research Purposes, Type and Page Count of Bibliographically Reviewed Studies

	NAME SURNAME	YEAR	RESEARCH PURPOSE	TYPE	PAGE COUNT
1	Gordon M. Shepherd	2012	-*Neurogastronomy: How the Brain Creates Taste and Why It is Important"* by Gordon M. Shepherd. -*"The role of smell in taste perception, the neural representation of the flavor phenomenon in the brain, flavor creation, and the relationship between flavor and memory are examined under subheadings such as the role of smell and taste in human evolution." "* -*"The aim of the book is to define and announce a new scientific field."*	Book	285
2	Jake Lahne	2013	-*" Nörogastronomi: How the Brain Creates Tastes and Why It Matters - Gordon M. Shepherd. A Book Review"*	Article	5
3	Rachel S. Herz	2016	*"An Examination of the Neuroscience, Clinical Medicine, Culinary Arts, Food Technology, and Agriculture Presentations and Demonstrations Featured at the Inaugural Symposium of the International Neurogastronomy Society Held at the University of Kentucky on November 7, 2015."*	Article	3
4	Jennifer Peace Rhind and Gregor Law Cooking	2018	*"The book is written on the neurogastronomy of cooking for the senses, specifically focusing on vegan cuisine."*	Book	322

	NAME SURNAME	YEAR	RESEARCH PURPOSE	TYPE	PAGE COUNT
5	Maiara dos Santos	2019	*"It aims to discuss Neurogastronomy, which examines the perception of flavors and how it occurs in the human brain."*	Article	18
6	Duran Cankül Nurcan Uslu	2020	*"The aim is to emphasize the significance of the senses in the perception of taste and flavors."*	Article	11
7	Esra Özata Şahin	2020	*"Making a case through scientific research and applications based on articles published in the Science Direct database, the study aimed to provide an assessment of the concept and development of neurogastronomy, the elements shaping flavor perception, and the potential impacts of neurogastronomy on the field of gastronomy."*	Article	12
8	Muhammed Yıldız Meral Yılmaz	2020	*"The aim is to contribute to the literature by collectively evaluating the trends emerging in the field of gastronomy and food and beverage, synthesizing their impact."*	Article	18
9	Jakub Berˇcík, Johana Paluchová Katarína Neomániová	2021	*"The primary objective of the article is to determine the effects of the visual presentation of foods, prepared from the same ingredients and served in three different ways, on consumer preferences."*	Article	17
10	İlkay YILMAZ Ecem AKAY Arda ER	2020	*"The study aims to establish a foundation for better understanding the fundamental concepts in the field of neurogastronomy and their impacts on marketing strategies in businesses."*	Article	14
11	İmren Akaloğlu	2021	*"The main objective of the research is to understand the role of flavor perception in marketing and restaurant businesses with the emergence of the concept of Neurogastronomy. In this context, the*	Thesis	169

	NAME SURNAME	YEAR	RESEARCH PURPOSE	TYPE	PAGE COUNT
			aim is to evaluate the methods used to assess the impact of neurogastronomy principles on the flavor perception by examining the experiences of customers visiting restaurants that have embraced neurogastronomy, reviewing their comments, and analyzing their reactions."		
12	Günay Hasdemir Nağme Boran Saime Küçükkömürler	2022	*"Scientific developments, trends, and studies in the field of neurogastronomy have been attempted to be evaluated, covering topics such as the concept of neurogastronomy, olfactory perception, taste concept, flavor concept, factors in flavor perception, sensations of temperature and texture, and assessments related to auditory and visual elements."*	Article	12
13	Ceyhun Uçuk	2022	*"The aim of this study is to determine the effects of food presentation on human taste perception within the context of neurogastronomy, gastrophysics, and synesthesia."*	Thesis	131
14	Hakkı Çılgınoğlu and Ülkü Çılgınoğlu	2022	*"This research aims to measure neurogastronomy awareness, determine which sensory perceptions are used to evaluate while consuming food, and examine the impact of colors on flavor perception."*	Article	18
15	Mehmet Şahan	2022	*"The aim of the study is to elucidate the developmental process of the emerging field of Neurogastronomy, identify the benefits it can provide, and contribute to the literature by laying the foundation for future research in this field."*	Article	7
16	Haticetül Kübra Erçetin and Eda Güneş	2022	*"According to this article, the aim of the study titled 'Current Changes in Neurogastronomy and Food Perception' is to examine and understand the relationship between nutrition and the*	Article	16

	NAME SURNAME	YEAR	RESEARCH PURPOSE	TYPE	PAGE COUNT
			nervous system. The study emphasizes the significant impacts of healthy and regular nutrition on daily life."		
17	Oğuzhan Dülgaroğlu	2023	*"This study addresses the meaning of neurogastronomy and its place in the field of gastronomy. Additionally, it discusses the impact of the five senses that humans possess within the scope of neurogastronomy on the experience of taste."*	Book chapter	14
18	Pelin Tokat and İlkay Yılmaz	2023	*"In the study, neurogastronomy, the concepts of taste and flavor, and the parameters influencing taste perception are addressed. Studies on plate presentation and the influence of atmosphere are examined, and the aim is to convey information through a comprehensive literature review."*	Article	10
19	Ayşe Şengül and Mesut Murat Adabalı	2023	*"In the study, a detailed examination of the field of neurogastronomy, emerging as a result of the integration of science and food."*	Article	17

Year-based distribution

Examining the development of academic studies on neurogastronomy over time, there has been a rapid increase since 2012. Particularly, a noticeable rise in interest in this field is observed from 2020 onwards. Based on the table, there is an increase in academic studies related to neurogastronomy from 2020. This year seems to represent a period where a higher number of studies are published compared to previous years. Although providing a precise numerical data point for determining the ratio is challenging, the overall trend indicates an increase after 2020. Considering the publication of more research in this year and the subsequent period, it can be said that academic interest in the field of neurogastronomy is steadily growing.

Table 2: Distribution of Academic Studies on Neurogastronomy by Year

Year	Number of Academic Studies
2016	1
2018	1

2019	1
2020	4
2021	2
2022	5
2023	3

Distribution by type

According to Table 1, the type distribution of academic studies on neurogastronomy is given below.

Table 3: Type Distribution of Academic Studies on Neurogastronomy

Year	Number of Academic Studies
Article	14
Thesis	2
Book	3

According to the table, it is noteworthy that most of the studies analyzed are articles. Articles stand out as an important type of academic resource that analyzes a specific topic in detail and presents current research findings. On the other hand, the number of theses is more limited. Theses usually include comprehensive research conducted by graduate students during their education and address a broader topic. On the other hand, books represent the least number of sources. Books generally cover the academic body of knowledge in a comprehensive manner, providing the opportunity to present in-depth information from a broader perspective. This table reveals that neurogastronomy literature is predominantly shaped by articles, but theses and books also make valuable contributions to the field.

Author-Based Analysis

Gordon M. Shepherd's book, published in 2012, is considered an important milestone in the field of neurogastronomy. It elaborates on the neuroscientific underpinnings of eating and drinking experiences, explaining the neurological interactions that shape people's perceptions and experiences of food. Shepherd's work has increased interest in neurogastronomy and accelerated research in this field. Recently, especially in 2020 and beyond, there has been a noticeable increase in the number of multi-authored studies. This situation reveals that scientists from different disciplines are more closely collaborating in the field of neurogastronomy. Interdisciplinary approaches are becoming increasingly important in neurogastronomy research. Researchers from different fields such as neurology, nutrition science, psychology, food science and technology, and perception psychology are expanding the scope of this discipline by combining their own specialized perspectives with neurogastronomy.

Experts in nutrition science and health psychology offer more detailed insights into individuals' eating habits, dietary preferences and perceptions of food (Shepherd, 2012). In addition, food science and technology experts contribute to neurogastronomy through the development of new food products and the improvement of existing production processes. This interdisciplinary collaboration increases both the breadth and depth of neurogastronomy research, allowing for a more comprehensive understanding of individuals' eating behaviors and food choices (Santos, 2019).

Purposes of the studies

When Table 1 is examined, it is seen that the objectives of the studies conducted in the field of neurogastronomy exhibit a diversity that reflects the various interests and purposes of this discipline. The studies conducted by Dieguez (2013), Santos (2019) and Uçuk (2022) focused on clarifying basic concepts and exploring the details of sensory perception. These studies aimed to examine the basic mechanisms of the interactions between flavor perception, olfaction and sensory modalities in the eating process. With this approach, the researchers aimed to contribute to a better understanding of the cognitive processes involved in gastronomic experiences. On the other hand, studies by Yılmaz and Sezgin (2022), Erçetin and Güneş (2022) and Rolls (2016) have a more practical focus. These studies aimed to examine the effects of neurogastronomy principles on marketing strategies in the food sector. Specifically, how insights from this field can be useful in improving product development processes, increasing consumer loyalty and guiding branding efforts. By evaluating the intersection of neuroscience and gastronomy from both theoretical and practical perspectives, these efforts have supported a holistic understanding of this field and paved the way for innovative applications in the business world. In conclusion, research in the field of neurogastronomy offers a broad perspective covering both the theoretical dimension and the practical benefits of this discipline. This diversity not only contributes to the understanding of the complex relationships between the brain and food, but also opens the door to innovative developments in areas such as gastronomic art, consumer behavior and eating habits. In all these aspects, neurogastronomy stands out as a promising discipline in terms of contemporary scientific studies and applications.

Distribution by Number of Pages

According to Table 1, the distribution of the number of pages of academic studies on neurogastronomy is given as follows.

Table 4: Number of Pages Distribution of Academic Studies on Neurogastronomy

Page range	Number of Studies
1-12	7
13-20	8
21 and above	4

This table shows the distribution of academic studies in the field of neurogastronomy according to the number of pages. Most studies are between 13-20 pages, followed by studies between 1-12 pages. More comprehensive studies are usually 21 pages or more. This distribution shows that research in the field of neurogastronomy is conducted in various dimensions and some studies are more in-depth.

The purpose and findings of the studies in the bibliometric analysis table:

Shepherd (2012), in his work written to define the discipline of neurogastronomy and to announce scientific developments in this field, examined the contribution of smell in flavor perception, the processing of the concept of flavor in the brain, how flavor is created, the relationship between flavor and memory, and the role of smell and flavor in human evolution. Under these sub-headings, he discussed in detail the complex structure of flavor perception and the various factors that affect people's eating experience.

In Lahne's (2013) study, Gordon M. Shepherd's book published in 2012 was analyzed and it was stated that Shepherd's willingness to conduct interdisciplinary research on the taste of food made an important contribution.

Herz (2016) discusses the mission of the International Neurogastronomy Association and states that the association aims to improve the quality of human life and to produce and disseminate knowledge about gastronomy and brain-behavior relationships in order to advance neurogastronomy as a craft, science and health profession. It was also emphasized that the association's research and applications in areas such as neuroscience, chemical senses, public policy, culinary arts, etc. have the potential to change the future of human health and happiness.

In the book by Rhind and Law (2018), it is stated that neurogastronomy brings an alternative and inspiring perspective on food and flavor, and that plant-based cuisine has broken several preconceptions by changing the way we perceive. This study focuses on the scientific underpinnings of the senses that help us understand our individual likes and dislikes and seeks to understand some of the culinary science on ways to maximize flavor. Different ingredients from the plant kingdom are explored in terms of flavor and recipes that reflect neurogastronomy in practice are presented.

The article by Santos (2019) discusses a relatively new discipline called neurogastronomy, which involves the perceptual process at the sensory level. This study provides a brief overview of neurogastronomy, highlighting the importance of this discipline for the fields of gastronomy, food industry, nutrition and medicine. It also emphasizes that neurogastronomy methods can help to improve taste in conditions such as eating disorders, chemotherapy and chemical dependency.

Cankül ve Uslu (2020) focused on how the senses are effective in the formation of taste and flavor perception and the importance of the senses in taste and flavor perception. Their study delved into the intricate relationship between sensory inputs and the perception of taste and flavor, shedding light on the crucial role of sensory mechanisms in shaping our experiences of taste and flavor.

Özata Şahin's (2020) study, based on articles published in the Science Direct database, made a situation assessment of the concept of neurogastronomy, its development, the

elements that make up the perception of taste and the potential effects of neurogastronomy in the field of gastronomy by providing examples from scientific research and applications.

Yıldız ve Yılmaz (2020) examined neurogastronomy and similar trends emerging in the gastronomy and food and beverage sectors. In this study, developments in the field of neurogastronomy as well as other important trends in the gastronomy and food and beverage sectors were also discussed. The research provides a perspective to understand the changing consumer preferences in the sector and the impact of these trends on businesses.

Berˇcík, Paluchová, and Neomá (2021) investigated how different presentation styles of waffles made from the same ingredients affect consumer preferences. The study evaluated three different presentation formats: traditional plate, street food-style box and luxury black stone plate. The findings show that waffles served on a black stoneware plate are perceived most positively at the conscious level. In addition, rectangular shaped foods were found to be more attractive than round shaped foods.

In Yılmaz, Akay and Er's (2020) study, topics such as the concept of neurogastronomy, taste and flavor concepts, parameters affecting flavor perception, odor perception, visual elements, auditory elements, temperature sensation and texture concepts were examined, and definitions related to neurogastronomy and marketing in food and beverage businesses were discussed. In addition, the study suggests that neurogastronomy, chefs and neurologists can come together to create a new scientific field and developments can be made in this field.

Akaloğlu's (2021) study aims to review the literature on neurogastronomy and taste perception and to examine the experiences of guests of famous restaurants operating in this field. For this purpose, the comments made by guests using neurogastronomy methods in world-renowned restaurants such as UV UltraViolet by Paul Pairet, El Celler de Can Roca and Alinea on TripAdvisor were analyzed. A total of 2402 reviews were taken into consideration and the data were analyzed using qualitative content analysis method with Leximancer 4.5 software. The results of the analysis show that these restaurants describe their guests' experiences on six themes: "food", "restaurant", "wine", "time", "flavor" and "reservation". As a result, it was found that people who visit restaurants that adopt neurogastronomy methods are highly influenced by these methods.

In the study of Hasdemir, Boran and Küçükkömürler (2022), scientific developments, trends and studies in the field of neurogastronomy, the concept of neurogastronomy, the concept of smell perception, the concept of taste, the concept of taste, the factors in the perception of taste, the concepts of temperature sensation and texture, auditory and visual elements were evaluated. As a result, various sub-headings of scientific studies in the field of neurogastronomy were examined and the contributions of these studies to the discipline of neurogastronomy were stated. These studies have examined how the senses interact to understand the complex processes of taste and flavor perception and how people perceive eating and drinking experiences. They also emphasized the importance of neurogastronomy in the fields of gastronomy, food industry, nutrition and medicine.

In the study conducted by Uçuk (2022), an experimental procedure was carried out to examine the food consumption process of humans on the axis of brain and taste using the neurogastronomy approach. In the experiments conducted in a Faraday cage, panelists were shown different presentations of food and sensory analysis was performed with electrical activity in the brain. The results showed that the presentation of food affects the perception of human taste. It was concluded that the centralized presentation of the dishes in Turkish cuisine increases the flavor.

In their study, Çılgınoğlu and Çılgınoğlu (2022) measured the awareness of neurogastronomy, determined which sensory perceptions are used in the evaluation of a food consumed, and investigated the effect of colors on flavor perception. For this purpose, interviews were conducted with Kastamonu University Faculty of Tourism students using a structured interview form. The most important finding obtained from the interviews with 32 participants was that established beliefs can change and that the senses can change the perception of flavor with neuroscience.

Şahan (2022) aimed to explain the development process of the field of neurogastronomy, to determine the benefits that can be obtained from this field and to contribute to the literature by forming the basis for future studies. As a result of the literature review, it was stated that there were limited number of studies on neurogastronomy at the national level. The study emphasized the positive effects of neurogastronomy on human health and revealed the importance of studies in this field. In particular, potential benefits such as eliminating harmful factors, changing eating and drinking habits positively, preventing diseases such as chronic obesity and providing cancer patients with a better quality of life were emphasized.

Erçetin and Güneş (2022) focus on the importance of the field of neurogastronomy and emphasize the nutritional relationship between sensory perception and the nervous system. Neurogastronomy includes studies aimed at improving the eating experience and making healthy foods perceived more delicious, as well as enabling individuals to taste the taste of food in disorders that cause damage to the sense of taste. In this context, this article examines the perception of neurogastronomy and the impact of neurological disorders on nutrition through a literature review. Studies show that the foods consumed can affect the course of existing disorders, quality of life and taste.

Dülgaroğlu (2023) discusses the definition of neurogastronomy and its role in gastronomy. He also presents a discussion on the effect of the five senses on taste experience within the framework of neurogastronomy.

Tokat and Yılmaz (2023) examine the relationship between the concept of neurogastronomy, gastronomy and neurology and discuss the effect of the five senses on the taste experience. This research addresses how sensory information is processed in the brain, the importance of visual presentation and the impact of plate arrangement on customers. It also focuses on the impact of technological developments on neurogastronomy and the factors that shape taste perception. The main purpose of the study is to provide a summary of current research in the field of neurogastronomy.

Şengül and Adabalı (2023) draw attention to the ability of neurogastronomy to create different taste perceptions by bringing the five senses together. They emphasized that although people consume the same food, their individual sensory experiences may

differ. The research findings reveal that studies on neurogastronomy have increased in recent years and that this discipline is becoming increasingly important in both marketing and gastronomy. This shows that neurogastronomy is gaining value not only as a scientific field but also as an approach that increases interaction between sectors.

This study reveals that the academic literature on neurogastronomy is relatively limited. While the dataset provides a sufficient starting point for understanding the development of the field, expanded datasets are needed to conduct in-depth content analyses or generalizations. Therefore, it is recommended that future studies cover more publications and examine interdisciplinary connections in more detail.

Conclusion

This study examines the bibliometric analysis of academic studies published in the field of neurogastronomy between 2006 and 2024 to reveal the development course, research trends and scientific contributions of the field. The findings show that interest in neurogastronomy has increased in recent years and that the field is becoming increasingly important from both scientific and applied perspectives. However, the limited number of 19 academic publications analyzed reveals that the literature is still in its infancy. The fact that neurogastronomy tries to explain how a holistic flavor perception is shaped by the combination of taste, smell, visuality, tactility, temperature and auditory elements indicates a potential to contribute to many disciplines, especially gastronomy and health sciences. In this context, Gordon M. Shepherd's Neurogastronomy, published in 2012, is considered to be one of the theoretical cornerstones of the field in terms of its in-depth understanding of the brain's response to taste and its relationship with memory.

Theoretical Outputs

- Neurogastronomy makes it possible to reinterpret traditional gastronomy approaches by revealing that sensory perception is not only limited to taste but also shaped by environmental and cognitive factors.
- The fact that the field is open to the integration of neuroscience, psychology, nutrition sciences and gastronomy paves the way for multidisciplinary research.
- The existing resources in the literature are shaped around the contributions of Gordon M. Shepherd in particular, and expanding and diversifying this structure will increase academic depth.
- The ability of neurogastronomy to explain the cognitive and emotional aspects of individuals' food preferences on a scientific basis makes it possible to establish new relationships between health behaviors and eating habits.

Practical Outcomes and Recommendations

- Expanding Application Areas: Neurogastronomy principles have a wide range of applicability from restaurant management to food design, from health services to educational programs. It is important to evaluate the effects of these applications with scientific methods.

- Training and Awareness: Planning neurogastronomy-based training programs for people from different sectors, especially nutritionists, chefs, restaurant managers and health professionals, will ensure that this knowledge is used more effectively in practice.

- Financial Support: Allocating more resources to neurogastronomy research by academic institutions, private sector and public organizations will encourage qualified and comprehensive studies in this field.

- International Collaborations: Projects that will encourage researchers from different countries to share knowledge and experience will enable neurogastronomy to reach a wider scientific scope on a global scale.

- Contribution to Health and Quality of Life: In the future, neurogastronomy-based studies are expected to encourage individuals to lead healthy lifestyles and contribute to the solution of obesity, eating disorders and sensory perception problems.

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