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The Future Direction of Halal Food Additive and Ingredient Research in Economics and Business: A Bibliometric Analysis

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Abstract: The increasing growth trend of the global Muslim population implies an increase in the consumption of halal products. The importance of the halal market attracts much attention from many stakeholders, including academia/researchers. Many scholars have conducted studies on halal topics. However, these studies cover broad topics, such as ICT potential in the halal sector, the halal supply chain, Islamic Law, and other halal studies related to natural sciences. This study aims to study the research gap and future trends of halal food additive and ingredient research in business and economics using bibliometric analysis. The data were obtained from the Scopus database from 1999 to 2022. The authors analyzed the keyword "Halal Consumption and Production" by using the general keyword "Halal or Haram Additive and Ingredient". The dataset was uploaded on VOSviewer and R language (Bibliometrix) software. This study found a deficit of studies on halal food additives and ingredients in business and economics. The co-occurrence network output demonstrated that future studies on halal food additives and ingredients should consider clusters that have lower density and central positions, such as production–consumption and the supply chain, healthy foods, and the logistics market and health effects. The Bibliometrix strategic diagram of the 2020–2022 thematic evolution demonstrates a research gap in three out of four quadrants (i.e., emerging or declining, basic, and motor themes). This study suggests potential research areas in the field of halal food additives and ingredients, such as ethical and sustainable sourcing, responsible consumption, consumer sovereignty, international trade, economic modeling, food security, green/sustainable supply chain, and halal regulation and product safety.

Keywords: halal production and consumption; halal and healthy foods; halal supply chain and logistics; sustainability

Citation: Nazaruddin, L.O.; Gyenge, B.; Fekete-Farkas, M.; Lakner, Z. The Future Direction of Halal Food Additive and Ingredient Research in Economics and Business: A Bibliometric Analysis. *Sustainability* **2023**, *15*, 5680. https://doi.org/10.3390/su15075680

Academic Editors: Colin Michael Hall and Flavio Boccia

Received: 13 February 2023
Revised: 10 March 2023
Accepted: 10 March 2023
Published: 24 March 2023

1. Introduction

The world's food consumers consider the ethics and sustainability of food consumption. Sometimes, ethical and sustainable reasons are opposed to tradition and religion. For example, the Japanese have a tradition of consuming whales which is associated with the ethics of the extinction of the whale population and the welfare of whales [1]. Moreover, many people oppose ethical issues and the tradition of dog meat consumption in some Asian countries [1]. From the religious perspective, some religions have diet rules such as the kosher rules for Jews and the halal rules for Muslims [2–4].

As the world's Muslim population grows [5], halal consumption and production will become significant issues. A halal thing in the Arabic language means lawful, while a non-halal thing means prohibited or haram in the Arabic language [2,6]. The consumption of halal foods is associated with healthy foods, animal welfare or ethics, food quality, purity, organic food, and food safety [2,6–11]. From an Islamic perspective, halal food consumption

contributes to the achievement of the goal of zero hunger and sustainable production and consumption [10,12]. All foods are halal except for foods made from pigs, the dead bodies of animals, parts of human bodies, animals slaughtered without mentioning the name of the Muslims' God, blood, alcoholic beverages, wine, ethyl, fanged animals, birds having talons to capture the prey, and halal foods contaminated with prohibited materials [2,6,13].

The importance of the halal market attracts great attention from at least three clusters of stakeholders: business, government, and academia. International consultants have regularly published the State of Global Islamic Economy Report (SGIER) since 2013; by 2022, it had released almost ten reports [14–22]. The SGIER reports on the market conditions, institutions, and business opportunities of Islamic economies such as those of the food and beverage, clothing and fashion, pharmaceutical and cosmetic, travel, media and recreation, and Islamic finance sectors [16,17].

DinarStandard reported that around 1.9 billion Muslims in the world spent USD 2 trillion on six economic sectors (i.e., halal food, modest fashion, cosmetics, pharmaceuticals, media and recreation, and travel) in 2021, and this is predicted to continue growing in the future [16]. Out of 2 trillion halal-related expenditures, Muslim consumers spent around 63.5% on halal food [16]. Some of the relevant critical drivers of Islamic economies in recent years are a rapidly growing Muslim population of a productive age, ethical consumption, halal standards and regulations, Islamic lifestyle and values, internet connectivity and e-commerce growth, and trade among members of the Organization for Islamic Cooperation/O.I.C. [14–16].

From a government perspective, some governments in Muslim countries implement halal standards or regulations. For example, in Malaysia, halal certification is under the Department of Islamic Development Malaysia (Jabatan Kemajuan Islam Malaysia/JAKIM) [23]. In Indonesia, the Government of Indonesia took over the halal certification authority from the Majelis Ulama Indonesia/Indonesia Council of Ulama (Civil Society Organization) in 2014 [24,25].

From an academic perspective, many scholars have published papers on halal products and services, ranging from economic and social sciences to natural and engineering sciences and from pure sciences to applied sciences. Some scholars have conducted studies on halal businesses [26–30]. Other scholars have conducted studies on halal from a social science perspective [31–34]. Some scholars have studied halal in the field of natural and technological/engineering sciences [35,36].

Many scholars have conducted bibliometric analyses of the halal sector. For example, some scholars [26,35,37] have conducted bibliometric analyses of ICT potential in the halal sector. The other scholars [37–41] have conducted review and bibliometrics analyses of the halal supply chain. Mamun and his colleagues [42] reviewed Islamic marketing, while Corte and his colleagues [3] conducted a bibliometric analysis of lawful and prohibited foods for Jews. Those papers provide the basis for further studies on the halal sector. However, the studies need more information on specific fields of study in the halal sectors, such as halal additives and ingredients.

The scholars mentioned above ignored food additives and ingredients that were possibly made from Shariah-prohibited animals and that were primarily produced in modern economies [2,6,43–46]. Food ingredients are substances used to make foods, while food additives are any substances added to foods [47,48]. Sometimes, food additives and ingredients overlap, and both are used interchangeably. A summary of food additives and ingredients is presented in Table 1.

Table 1. Summary of food additives and ingredients.

Division	Source/Categories/Functions	Reference
Food ingredients	Source: Animals, plants, and synthetic and fermented materials	[43]
	Functions: Preservatives, sweeteners, color additives, flavors, spices, flavor enhancers, fat replacers, nutrients, emulsifiers, stabilizers, thickeners, binders, texturizers, leavening agents, anti-caking agents, humectants, yeast nutrients, dough strengtheners and conditioners, firming agents, enzyme preparations, and gasses.	[43]
	Functions: Maintaining/improving safety and freshness, controlling contamination, improving/maintaining nutrition, improving taste, texture, and appearance.	[47]
Food additives	Three major categories: Flavoring agents, enzyme preparations, and other additives.	[48]
	Functions: Colors, emulsifiers, acids, stabilizers, preservatives, raising agents, flavor enhancers, acidity regulators, gelling agents, sweeteners, antioxidants, thickeners, emulsifying salts, grazing agents, flour treatment agents.	[49]
	Functions: Anti-caking agents, antioxidants, artificial sweeteners, emulsifiers, food acids, colors, humectants, flavors, flavor enhancers, foaming agents, mineral salts, preservatives, thickeners and vegetable gums, stabilizers and firming agents, flour treatment, glazing agents, gelling agents, propellants, raising agents, bulking agents.	[50]
	Source: Plants, animals, minerals, or synthetic materials.	[48]
	Direct food additives: Additives added directly to foods for a specific purpose in those foods, such as texture and binding (e.g., xanthan gum in salad dressings and aspartame in soda). Indirect food additives: Additives added indirectly to the food which become part of the food in differing amounts due to packaging, storage, or other handling methods.	[47,51]
	Natural food additives: Additives originating from natural food sources (e.g., red beets for natural red food coloring). Artificial food additives: Additives not originating from natural sources (e.g., several vanillas extracted from vanillin produced in a laboratory).	[51]
	Natural antioxidants: Polyphenols, ascorbic acid, carotenoids (source: from plants).	[52]
	Natural antimicrobials: Bacteriocins, natamycin, reuterin (source: from microorganisms); Poly-L-Lysine, lysozyme, lactoperoxidase, lactoferrin (source: from animals); polyphenols and essential oils (source: from plants).	[52]
	Natural Colorants: Annatto, paprika, beta carotene, lutein, carotenoids, anthocyanins, betalains, chlorophylls, curcumin, carminic acid (source: from plants).	[52]
	Natural sweeteners: Erythritol and tagatose (source: bulk sweeteners); steviol glycosides, glycyrrhizin, and thaumatin (source: the high potency one).	[52]
Halal food additives and ingredients	Source: Plants, Islamic-allowed animals, animals slaughtered by mentioning the name of the Muslims' God, and synthetic ingredients.	[43]
Doubtful food ingredients	Source: Gelatin, glycerine/glycerol, emulsifiers, enzymes, dairy ingredients, alcoholic drinks, animal protein/fat, flavorings, and compound mixtures, taurine, pepsin, clarifiers, stabilizers, cloudifiers, active carbon, and flavors.	[43]
Shariah-prohibited food additives and ingredients	Source: By-products of pigs, blood, alcohol and liquor, dead animals, and animals slaughtered without the mentioning of the name of the God of Muslims.	[6,13,43,53]

Source: the authors.

The production and utilization of food additives and ingredients are highly supportive of the global food security initiative, as promoted by the U.N. [12], due to their nutritional contents. "Food security" can be understood as the state in which everyone "at all times has physical, social, and economic access to sufficient, safe, and nutritious food", fulfilling "their dietary demands" and "food preferences for an active and healthy life" [54]. The definition is broken down into "six dimensions of food security", as follows: the first dimension is agency, implying the inclusion of all people; the second dimension is stability, implying

short-term capability; the third dimension is sustainability, implying long-term capability; the fourth dimension is accessed from the physical, social, and economic perspectives; the fifth dimension is availability, implying sufficiency; and the last dimension is utilization, implying safety, nutrition, and dietary demands [54]. The better performance of the food security initiatives in all the dimensions contributes to the achievement of the zero hunger goal [12,54].

The food and ingredient additives and the ingredients are crucial because they fulfill the above utilization dimension of food security. It is confirmed that food ingredients are the source of high nutrition values [55,56]. A European study found that food additives and ingredients indicate quality and healthy foods [57].

However, other scholars argue that healthy food contains no "problematic ingredients" [58]. The food security's utilization dimension encounters challenges such as "the increasing level of obesity, bad diversity of diet, a food safety problem, unhealthy and unsustainable diets" [54]. Food additives and ingredients partially contribute to the challenges. Some of the other food additives and ingredients are controversial because they contain risks in addition to their benefits. The summary of some of the health risks of food additives and ingredients is presented in Table 2.

To minimize the adverse effects of food additives and ingredients, everyone applies "healthy and sustainable diets", fulfilling the following requirements: first, quantity: adequacy of food energy to maintain life and to reach and keep the ideal body weight; second, diversity: consumption of a wide variety of essential foods with denser nutrition; third, quality: consumption of "necessary macro- and micro-nutrients with minimum unhealthy additives"; and fourth, safety: consumption of safe foods and beverages [59]. Healthy and sustainable diets are relevant to the Islamic context, in which Islam teaches its believers to consume halal foods and to consider the aim, sources, and quantity of what they consume [10].

Table 2. Summary of risks of food additives and ingredients.

Reference	Chemical and Food Additives	Function/Use	Health Concern
[60]	Bisphenols (indirect)	Polycarbonate plastic containers,	Endocrine disruption,
		Polymeric and epoxy resins in F&B cans	obesogenic activity, neurodevelopmental disruption
	Phthalates (indirect)	Clear plastic food wrap	Endocrine disruption
		Plastic tubing, storage containers used in industrial food production	Obesogenic activity
		Multiple uses in food manufacturing equipment	Oxidative stress and cardiotoxicity
	Perfluoroalkyl chemicals/P.F.C.s (indirect)	Grease-proof paper and paperboard	Immunosuppression, endocrine disruption, obesogenic activity, decreased birth wt.
	Perchlorate (indirect)	Food packaging	Thyroid hormone disruption
	Nitrates and nitrites (direct)	Direct additives as preservatives and color enhancers, especially to meats	Carcinogenicity, thyroid hormone disruption
[61]	Brominated vegetable oil	Emulsifier (soda, sports drinks)	Harmful to the nervous system
	Potassium bromates	Dough conditioning (bread, noodles, dough-based products)	Increased risk of cancer

Table 2. *Cont.*

Reference	Chemical and Food Additives	Function/Use	Health Concern
	Nitrate and nitrite	Antimicrobials/meat preservatives (processed meat)	Increased risk of cancer
	Propylparaben	Antimicrobials/preservatives (processed meat)	Increased risk of cancer
	Butylated hydroxy anisole (BHA); butylated hydroxy-toluene (BHT); propyl gallate; tert-butyl hydroquinone (TBHQ)	Antioxidants/preservatives (processed meat, ready-to-eat cereal, flour-based snacks)	Increased risk of cancer and change to the immune system
	FD&C colors (Red 3 and 40, Yellow 5 and 6, Blue 1 and 2, and Green 3)	Synthetic colorants (candy, ready-to-eat baked goods, chips and snacks, cereal, soda)	Neurobehavioral problems in children
	Titanium dioxide	Mineral colorants (candy, ready-to-eat baked goods, ice cream)	Change to the immune system in the digestive tract
	Acesulfame potassium, advantame, aspartame, neotame, saccharin, sucralose	Non-nutritive synthetic sweeteners (diet beverages and other prepared beverages, ice cream)	Weight gain and change in metabolism
	B.P.A.	Food packaging chemicals	Endocrine disruptors
	PFAS	Food packaging chemicals	Harmful to the immune system and the developing fetus and increased risk of cancer
	Phthalates	Food packaging chemicals	Endocrine disruptors
[62]	Sodium nitrites	Stabilizer, color and flavor meat, control of bacterial growth (processed meat)	Increased risk of pancreatic and colorectal cancer
	Sulfites	Preservatives (fresh fruits, vegetables, and other foods)	Aggravates asthma
	Trans fats	Hydrogenated oils in cookies, crackers, and other packaged foods	Increased risk of heart disease
	Monosodium glutamate (M.S.G.)	Flavor and texture enhancers (Asian foods such as soups and other processed foods)	Nausea, breathing problems, other reactions, an increase in blood pressure
	FD&C yellow 5 and 6	Artificial coloring agents (candy and cereal)	Allergic reactions in those with asthma and hyperactivity in children
[51]	Artificial food additives	Processed foods	Problems with digestion (gut disorders),
	Artificial/non-nutritive) sweeteners (aspartame, acesulfame K, saccharin, and sucralose)	Processed foods and beverages	Weight gain

Table 2. *Cont.*

Reference	Chemical and Food Additives	Function/Use	Health Concern
	Nitrate and nitrite	Antimicrobials/meat preservatives (processed meat)	Increased risk of cancer
	Propylparaben	Antimicrobials/preservatives (processed meat)	Increased risk of cancer
	Artificial additives (Nitrites and nitrates)	Processed meats	Higher risk of cancer
	Bisphenol A (B.P.A.)	Food packaging	Higher risk of cancer and endocrine disruption
	Artificial additives	Food coloring and flavorings	Children's health: hyperactivity, attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (A.S.D.), behavioral issues (neurodevelopment disorders)
[63]	Artificial sweeteners	-	Increased risk of cancer and cardiovascular diseases
	Nitrates and nitrites	Processed meat	Increased risk of cancer
	Emulsifiers	Emulsifiers	Problems with the digestive system

Source: the authors.

Because of the risks contained in food additives, the use of food additives and ingredients is subject to regulation and control by the government to guarantee food safety because of the potential harm to the health of humans [47,48,60]. Under halal regulations [64], the halal status and harmful contents of the foods (tayyib principle, meaning wholesome and fit for consumption) are examined so that the foods will be certified for halal [6,7,65]. In this case, Islamic teaching is highly concerned with food safety and healthy food.

Based on the above data and arguments, this study investigates the research gap in the halal sector. Together with the previous studies involving bibliometric analysis, this study considers the future trends in halal food additive and ingredient research in economics and business. This paper is organized as follows: the methodology is in Section 2; the results and discussion are covered in Section 3; and the paper ends with a conclusion.

2. Methodology

Bibliometric analysis was selected to investigate the research gap in the halal sector because it can monitor and evaluate the progress of the "sciences" and "technologies", as suggested by Osareh [66].

2.1. Data Sources

Waltman [67] suggests three bibliometric analysis databases: the web of science, Scopus, and Google Scholar. However, the authors only used a dataset from the Scopus database [68]. The Scopus database was used for the primary bibliometric analysis because Scopus has a wide range of data [67].

It is recommended to use keywords for effective searching on the Scopus website [69]. The Boolean operators "AND", "OR", and bracket were used to extract the dataset using the intended keywords. The database includes a citation, bibliographical information, abstracts and keywords, funding detail, and other information [68]. Data from other relevant sources were also used in this study.

2.2. Techniques, Data Processing, and Analysis

The authors considered various kinds of literature on bibliometric techniques [70–72]. Based on Aria's and Cuccurullo's classification [70], the authors were interested in analyzing the domain and structure of the knowledge, as presented in Table 3. The domain analysis concerns the productivity of the scientific works, while the knowledge structure analysis concerns the emergence of "new at crossroads among structures and time evolution" [70].

Table 3. The adopted techniques, methods, and visualization of bibliometrics.

Focus	Level of Analysis	Metrics			Software
Domain	Overview	Primary information, annual scientific production, average citation per year			RStudio
	Sources	Most relevant sources, most locally cited sources, and impact metrics			
	Authors	Authors (author impact, most relevant authors, and most locally cited authors) and affiliations (most relevant affiliations)			
	Documents	Words (WordCloud)/trend topics			
Knowledge structure (K structure)	Structure: Conceptual structure	Techniques: Co-word (Co-occurrence)	The unit of analysis: Keyword Plus (I.D.)	Statistical techniques: Co-occurrence network, and thematic evolution	RStudio and VOSviewer

Source: the authors, based on [70,71,73–75].

A VOSviewer software simulation was used, as recommended by some scholars [72,73,75], using the Scopus dataset. In addition to VOSviewer, some scholars [70,71,74,76] suggest the use of R language (RStudio) to perform bibliometric analysis, as presented in Table 3. The R packages were installed using the command "install.packages("bibliometrix")" and by running the command "library (Bibliometrix)" and then "biblioshiny()", which connected us to the web-based R programming [70,71,76].

After obtaining the outputs of RStudio and VOSviewer, the authors carried out some steps to improve the visualization. In this stage, the authors referred to some studies [70–73,77–80], that suggest processing and analysis steps, as shown in Figure 1.

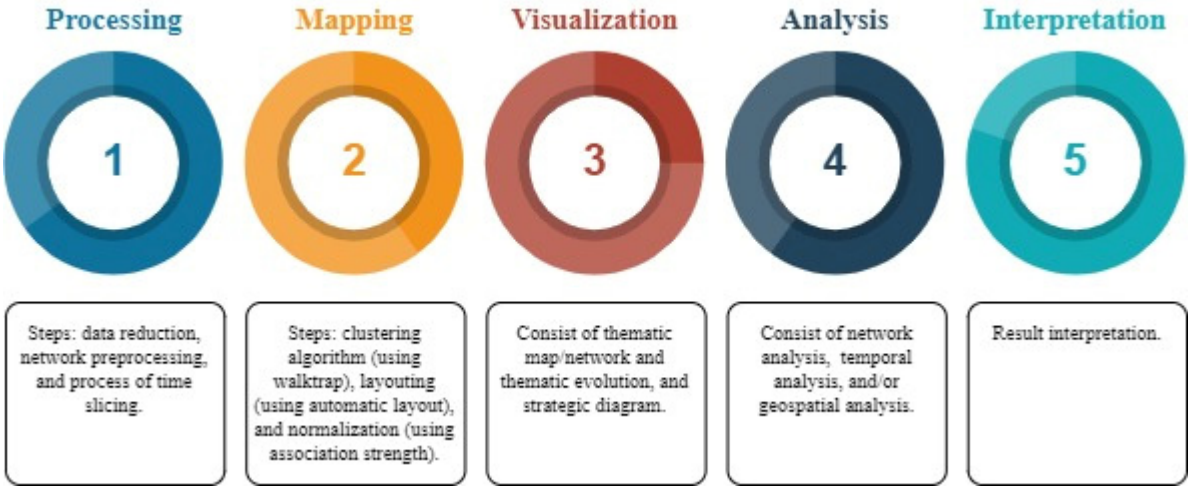

Figure 1. The procedure of processing and analysis (source: the authors, based on [70–73,77–80]).

To analyze the visual network/graph/diagram, Cobo and his colleagues [72] suggest methods such as "network, temporal, or geospatial analysis". Aria and Cuccurullo [70] point out that a network analysis plot can be interpreted based on following five criteria: first, the position or location of the network: in the periphery (implying an emerging or declining state) or in the center (implying an established state); second, the "bubble

dimension", implying the number of citations; third, the "strength relationship": weak links (weak relationship) or heavy links (strong relationship); fourth, cluster (color indicating the number of the cluster) and the density of the network (high density: developed, or low density: underdeveloped); fifth, bridges.

Callon's strategic diagram was used; this was first created by Callon and his colleagues [77] and then developed by Aria and Cuccurullo [70] for bibliometrics using the R language, as presented in Figure 2. They [70,77] then associate Callon's strategic diagram and the network analysis plot.

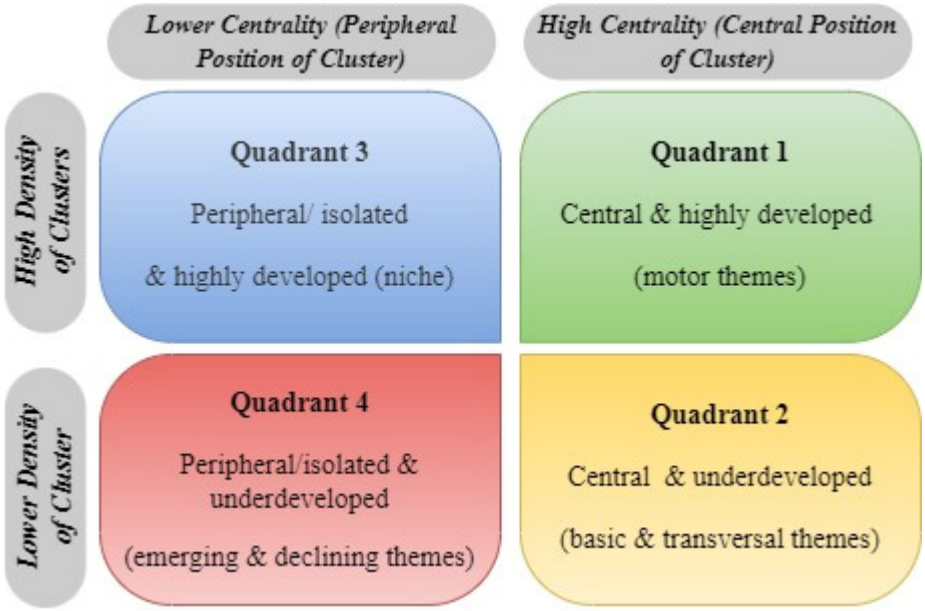

Figure 2. Callon's strategic diagram (source: reproduced by the authors based on [70,71,77]).

2.3. Topic Selection

The authors searched for specific keywords using Boolean operators and extracted some datasets from the Scopus database on 15 December 2022. The authors began with general keywords and extracted the dataset, as in Table 4 (number 1). Based on the dataset, the authors performed a WordCloud metric document analysis under a domain analysis, with the number of words set to one million to demonstrate the trending issues, and obtained a WordCloud graph, as presented in Figure 3. Based on the WordCloud graph, it is evident that the words article, human, and meat have a higher centrality and are denser than the other words. However, those words should be a concern. The peripheral and denser words in Figure 3 (e.g., gelatin, collagen, Animalia, diet, certification, and halal) can be classified into one general term: additives and ingredients [44–46,81,82]. The authors then focused on the term additives and ingredients because it was almost neglected in previous studies employing bibliometric analysis [3,37–42]. The authors then searched for keywords related to halal additives and ingredients, as presented in Table 4 (number 2), and extracted the Scopus dataset (please see the Supplementary Material). The following section discusses the results of the bibliometric analysis of the second keyword in Table 4 (number 2).

Table 4. Queries on Scopus database using Boolean operators.

Nr	Keywords	Nr of Results	Years of Coverage	Time of Access
1	((halal) AND (production OR consumption)) AND (EXCLUDE (PUBYEAR, 2023))	588	1990–2022	15 December 2022
2	((halal OR haram) AND (ingredient OR additive))	222	1999–2022	15 December 2022

Source: the authors' queries on [68].

Figure 3. WordCloud analysis of keyword "Halal Consumption and Production"; number of words: one million (source: the authors' simulation based on data from [68]).

3. Results and Discussion

In this section, the authors analyze and discuss the outputs of the bibliometric software (VOSviewer and RStudio) based on the keyword "halal or haram additive and ingredient" extracted from the Scopus database. The summaries of the results are as follows: the period was from 1999 to 2022; the number of sources was 140; the number of documents was 222, written by 783 authors, with an average document age of 4.88 years and an average of 12.3 citations per document [68].

The scientific production (number of articles) grew slowly until 2012, when the number of publications was mostly below ten, and the articles were not produced consecutively. Scientific production began to increase rapidly after 2012, as presented in Figure 4. The first paper on halal-haram additives and ingredients was written in 1999 (which had only one paper) by Morrison and his colleagues [82] titled "Gelatin alternatives for the food industry". In 2001, two papers [83,84] were published. In 2004, there were two articles published in magazines, titled "New products: Anderol 6000 series food grade lubricants" [85] and "The value of halal food production" [86]. Lastly, there were 25 papers published in 2022, decreasing from 2020, which had 32 publications. Even if the number of publications increased from 1999 to 2022, the average citation per article still needs to be higher, but below five citations, as presented in Figure 4.

From the perspective of the source analysis, the articles covering the keyword "halal or haram additive and ingredient" were primarily published in high-quality journals in Western countries (non-Muslim countries). However, Muslim countries (members of the Organization for Islamic Cooperation/O.I.C.), such as Malaysia and Indonesia, have begun to have high-quality journals covering the study field of halal. The three highest quality journals are the *Journal of Islamic Marketing* (UK) with an H-Index of 7; *Trends in Food Science*

& Technology (UK) with an H-Index of 5; and *International Food Research Journal* (Malaysia) with an H-Index of 4, as presented in Figure 5 (top). The journals having a high impact in Figure 5 (top) were plotted again according to the most locally cited parameter, as presented in Figure 5 (bottom).

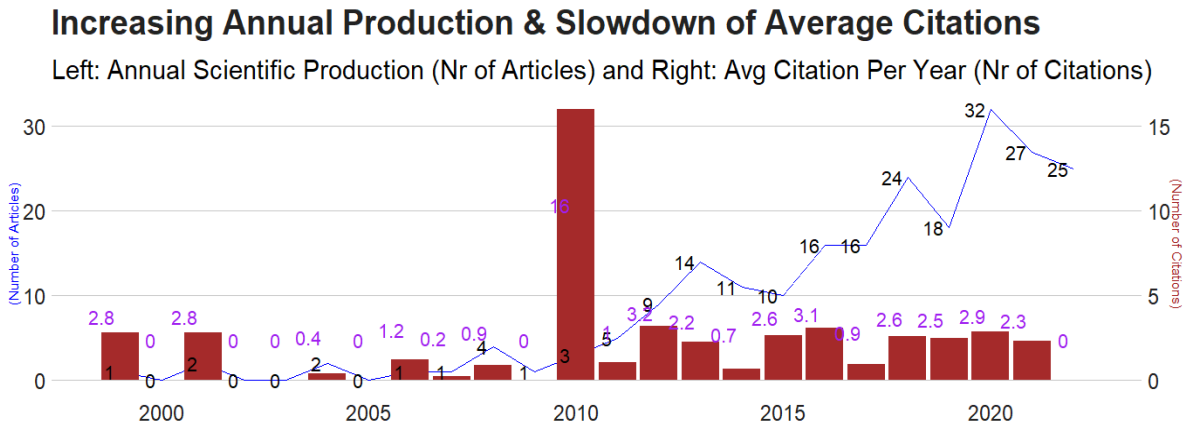

Figure 4. Overview of scientific performance (source: the authors' plot based on data from [68] and R output (Biblioshiny)).

Figure 5. Source impact (source: the authors' plot based on [68,87], and R output (Biblioshiny)).

Figure 5 (bottom) demonstrates that the most locally cited journals are: *Food Chemistry* in the UK (222 articles); *Journal of Islamic Marketing* in the UK (167 articles); *Meat Science* in the Netherlands (161 articles); *Food Hydrocolloids* in the Netherlands (106 articles); *Journal of Food Science* in the U.S. (86 articles); and *Journal of Agricultural and Food Chemistry* in the U.S. (86 articles). The most locally cited sources are primarily in Western, non-Muslim countries. Local citation means citations by those living in the countries where the journals are published. There are some reasons for why Western journals are the most locally cited. First, Western journals have high quality, as confirmed in Figure 5 (top); so, they receive many citations from everywhere. Second, Western countries have a good reputation for higher education institutions, attracting many people worldwide, including those from Muslim countries, to study there. Those from Muslim countries studying in Western countries performed research on the halal sector and read the Western countries' high-quality journals. Third, the staff of private companies in Western countries, including employees of producers of halal foods, read journals and perform research. SGIER 2022 confirms that top exporters of halal products mainly come from Western countries [16]. The staff of the companies read halal-related articles for business expansion (supply side of halal products).

From the perspective of authorship analysis, the total affiliations comprise 180 institutions from 34 countries. Most of the authors' affiliations come from Malaysia (31.7% or 57 institutions), Indonesia (18.9% or 34 institutions), and Pakistan (7.8% or 14 institutions). When the pie chart is simplified (Figure 6), the results are as follows: the first largest affiliation comes from Malaysia; the second largest affiliation comes from Indonesia; the third largest affiliation comes from Middle East countries (14.4% or 26 institutions); the fourth largest affiliation comes from South Asian countries (12.2% or 22 institutions); and the fifth largest affiliation comes from Central and South European countries (6% or 11 institutions). This means that most of the authors and readers of the papers come from Muslim countries because they are halal consumers (demand side), and the countries certainly have producers of halal products (supply side). Thus, those Muslim countries implement Islamic economies, lifestyles, and halal standards. It is confirmed by SGIER 2022 reporting that the top five in the Global Islamic Economy Indicator are Malaysia, Saudi Arabia, U.A.E., Indonesia, and Turkey [16].

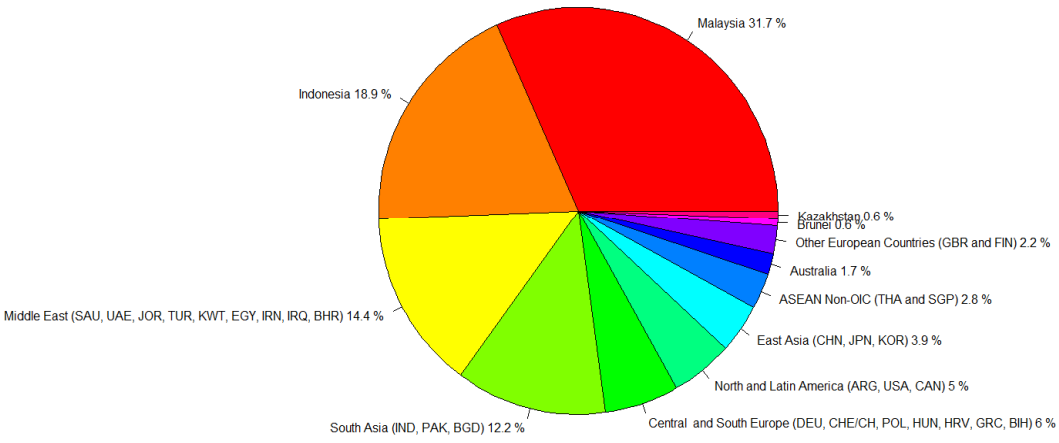

Figure 6. Authors' affiliations by country: 180 institutions from 34 countries (source: authors' plot based on [68] and R output (Biblioshiny)).

The sum of author affiliations from non-Muslim countries results in high share of the affiliation. The high share of author affiliations from non-Muslim countries is due to the following reasons. First, those countries have a better reputation in higher education; their students/researchers published some papers on halal or haram additives and ingredients. Second, those countries have private companies concerned with exporting halal products to Muslim countries (supply side). It is confirmed that some non-Muslim countries are top

exporters of halal food and beverage (F&B) products to Muslim countries, as presented in Table 5.

Table 5. Top exporters of halal F&B products to Muslim countries.

Top Exporters 2018 and Value (USD Billion)	Top Exporters 2019 and Value (USD Billion)	Top Exporters 2020 and Value (USD Billion)
Brazil: 5.5	Brazil: 16.2	Brazil: 16.45
Australia: 2.4	India: 14.4	India: 15.35
India: 1.7	USA: 13.8	USA: 13.22
Sudan: 0.62	Russia: 11.9	Russia: 12.74
Turkey: 0.55	Argentina: 10.2	China: 9.54
-	-	Argentina: 8.53
-	-	Indonesia: 7.83
-	-	Ukraine: 7.70
-	-	Turkey: 7.41
-	-	France: 6.14

Source: the authors, compiled from [14–16].

As pointed out in Figure 6, Malaysia shares 31.7% of the author affiliations at the country level; Malaysia's higher share is mainly due to the contributions of International Islamic University Malaysia (58 articles), Universiti Kebangsaan Malaysia (48 articles), and Universiti Teknologi Mara (34 articles). Indonesia's author affiliations are in the top 10, from Universitas Brawijaya (16 articles) and Universitas Gadjah Mada (14 articles), as seen in Figure 7.

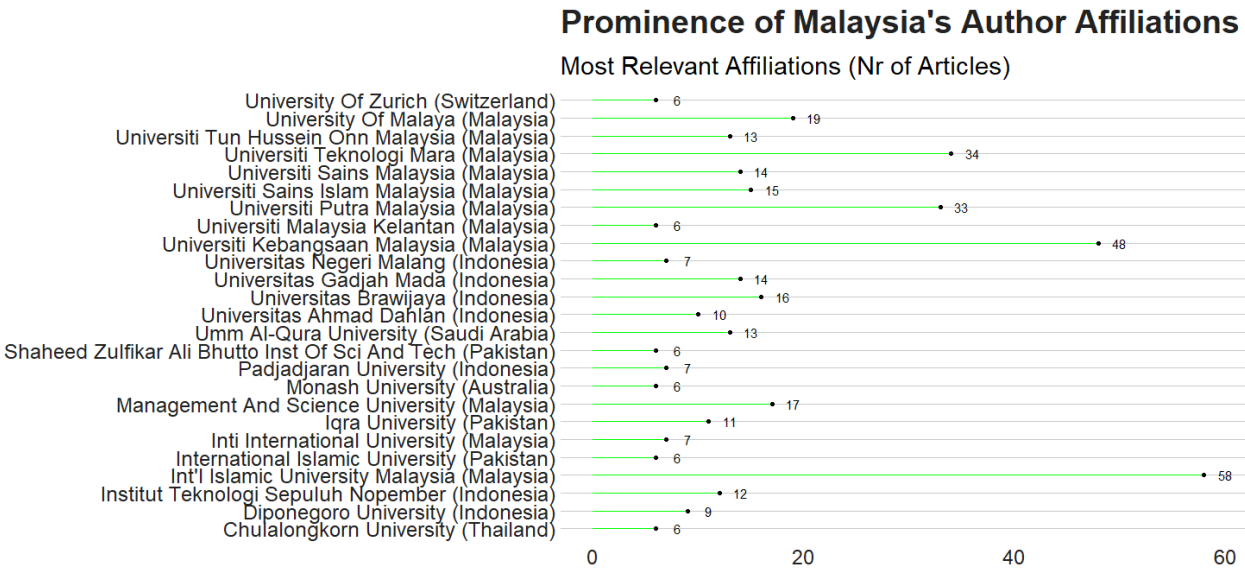

Figure 7. Top affiliations of authors by Institution (source: authors' plot based on [68] and R output (Biblioshiny)).

Malaysia performed better in scientific publications than Indonesia because the Government of Malaysia implemented the halal standard earlier than the Government of Indonesia, putting Malaysia in first place in the Global Islamic Economy Indicator Score Rank for eight years consecutively [14–16,18–22]. Indonesia's experience portrayed the long history of involvement of the Islamic civil society organization, the so-called Majelis Ulama Indonesia/MUI (Indonesia Ulama Council), in halal certification. MUI previously

issued a halal certification to private companies that voluntarily registered for halal certification with them. In 2014, the Government of Indonesia adopted the Law on Halal Product Assurance [24]. It imposed mandatory halal certification for private companies (the shift from voluntary certification by civil society organizations to mandatory certification by the government), but it was ineffective. Since then, publications on halal have still needed more attention from scholars. The Government of Indonesia adopted the 2020 Law on Job Creation (Undang-Undang No 11/2020 tentang Cipta Kerja) [88] aimed at spurring economic development; it included some issues related to halal certification such as high cost and the long period of time required for halal certification [89]. To guide the implementation of the Law, the Government of Indonesia adopted the 2021 Government of Regulation of Implementation of Halal Product Assurance [25]. In addition, the Government of Indonesia established the National Committee for Sharia Finance and Economy (Komite Nasional Ekonomi dan Keuangan Syariah/KNEKS) under the 2020 Presidential Decree (Peraturan Presiden Nomor 28 Tahun 2020 tentang Komite Nasional Ekonomi dan Keuangan Syariah) [90]. With the government's commitment, Indonesian scholars published more about halal issues.

In the co-occurrence analysis, VOSviewer software was used. The minimum number of occurrences of the keyword was two, resulting in 293 keywords meeting the threshold out of the 1704 keywords and 11 clusters. After adjusting the resolution of the cluster from 1.0 to 0.5, the number of clusters changed from 11 clusters to 5 clusters. The five clusters are as follows: cluster 1 (red) represents topics of production, consumption, and the supply chain of halal additives and ingredients; cluster 2 (green) represents market and control/regulation of halal additives and ingredients; cluster 3 (blue) represents detailed types of halal additives and ingredients, raw materials, and their productions; cluster 4 (yellow) implies healthy foods; and cluster 5 (purple) implies logistics, the market, and health effects, as presented in Figure 8.

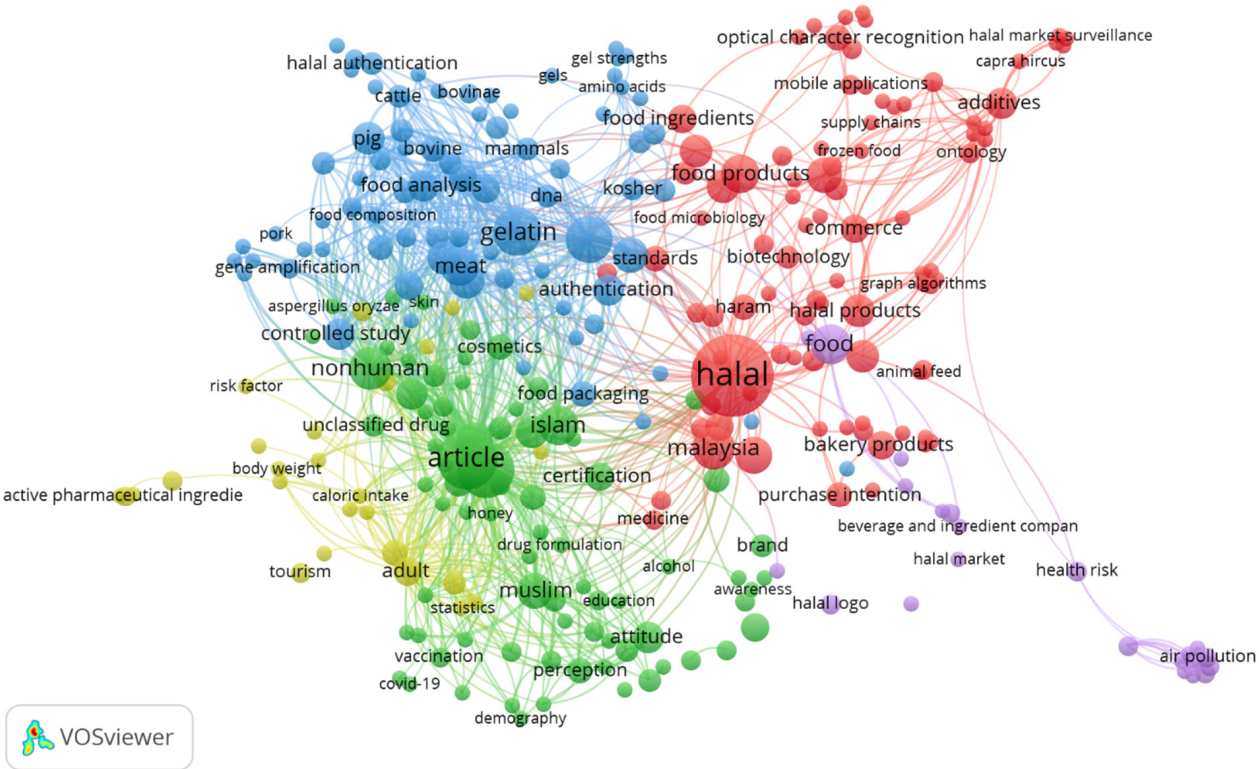

Figure 8. Co-occurrence network for keyword "Halal or Haram Additive/Ingredient" (source: the authors' plot using the VOSviewer tool based on data from Scopus [68]).

According to Callon's classification of centrality and density [77], the clusters in Figure 8 have two meanings: first, cluster 2 is in the center of a network, implying that the topics in the cluster are uncovered and become the primary concern of many scholars, while the other clusters are in the periphery of the network, implying that the topics in these clusters are still isolated; second, cluster 2 and cluster 3 have higher density, implying that the topics are more developed, while cluster 1, cluster 4, and cluster 5 have a lower density, implying that the topics are still underdeveloped. This will be discussed in later paragraphs.

As presented in Figure 8, the large-sized circles represent the most frequently occurring topics, while the small-sized circles represent the less frequently occurring topics. Detailed information on the most frequently occurring topics and the most vital links to the topics is presented in Figure 9. Some topics, such as halal, article, human, animals, gelatin, nonhuman, and Islam, have consistently high occurrences and the most vital links; most of topics are in cluster 2 (green). This means that the topics are mainly studied with co-occurrence network analysis. The most frequently occurring topics and the most vital links of the keywords for each cluster are presented in Table A1 (Appendix A). The number of occurrences in cluster 2 (green) is higher than in the other clusters. In addition, the scores of the link's strengths in cluster 2 (green) are higher than those in the other clusters. This means that clusters other than cluster 2 (green) are potential future study areas.

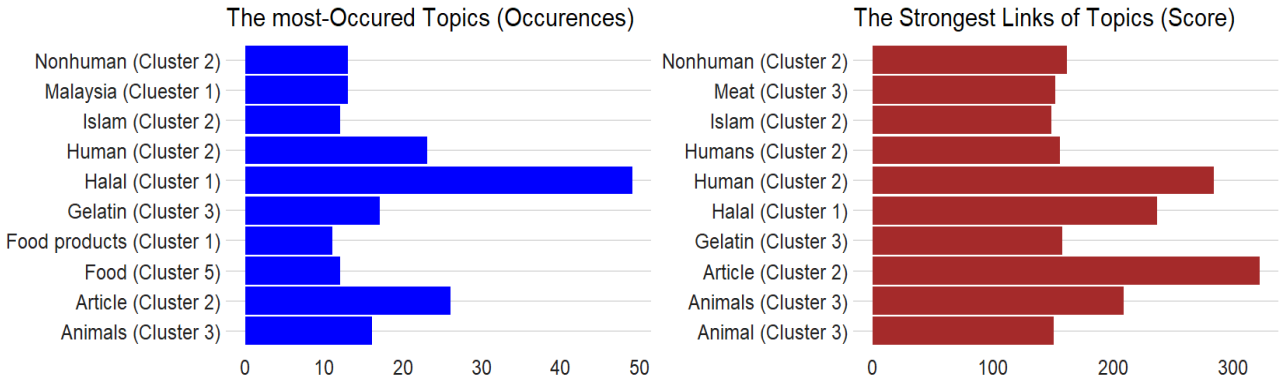

Figure 9. The most frequently occurring topics and the strongest links of topics (source: the authors' plot based on [68] and VOSviewer thesaurus).

As discussed earlier, the co-occurrence network implies the centrality and density of the network, and the thematic evolution of the co-occurring topics was plotted in a strategic diagram using RStudio (bibliometrix library). Because the time evolution was divided into two time spans, 1999–2019 and 2020–2022, the evolution was plotted in two strategic diagrams, explaining the detailed distribution of the topics in four quadrants. Each quadrant consists of new clusters that are different from the VOSviewer's clusters. The reasons for the division into two periods are: first, because of situation of the COVID-19 pandemic many scholars published their articles during the COVID-19 outbreak, as presented in Figure 4; second, the COVID-19 pandemic led to food insecurity due to the decline in production, the disruption of the supply chain, and the restriction on trade [91]; third, the Ukraine–Russia war broke out, leading to food insecurity [12,92].

Using the keyword "halal or haram additives and ingredients", strategic diagrams were plotted, as presented in Figure 10a for the thematic evolution from 1999 to 2019 and Figure 10b for the thematic evolution from 2020 to 2022. The large-sized circles represent the most frequently occurring topics, while the small-sized circles represent the less frequently occurring keywords. The 1999–2019 thematic evolution in Figure 10a consists of 15 clusters distributed into four quadrants. First, the quadrant of emerging or declining themes (peripheral/isolated and underdeveloped) has five clusters: oils and fats have one topic, ethanol has one topic, food-grade lubricants have one topic, water quality has one topic, and chromatography has one topic. Second, the quadrant of basic themes (central but underdeveloped) has two clusters: food products have seven topics and food quality has

four topics. Third, the quadrant of niche themes (peripheral/isolated but highly developed) has three clusters: bakery products have four topics, additives and business have nine topics, and mobile computing has six topics. Fourth, the quadrant of motor themes (central and highly developed) has five clusters: halal and food industries have 13 topics; gel strengths have 4 topics, articles and demographic conditions have 27 topics, animal origins and markets have 30 topics, and food analysis has 11 topics. A detailed explanation is presented in Table A2 (Appendix B).

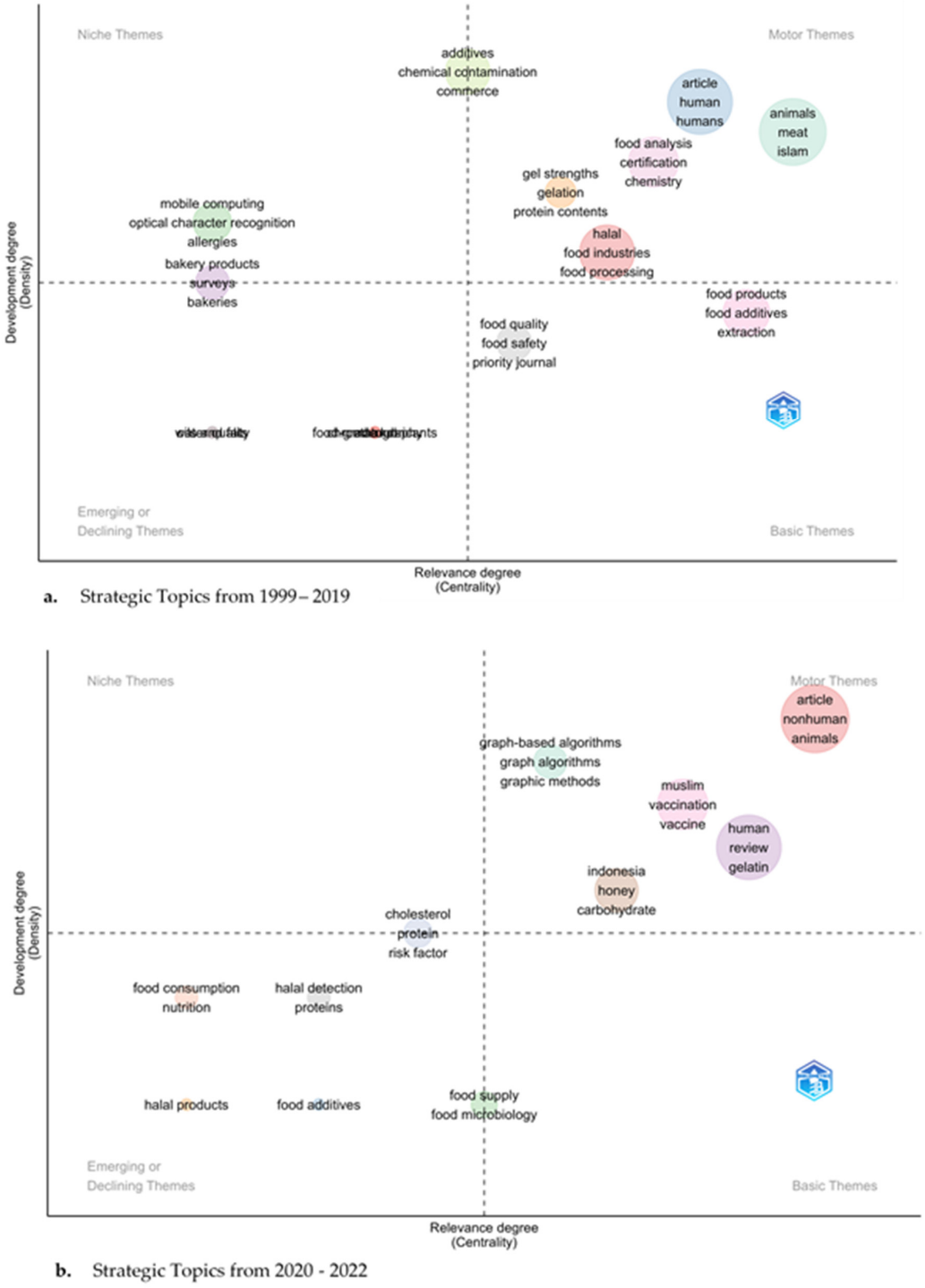

Figure 10. Evolution of Strategic Topics: Keyword "Halal or Haram Additive/Ingredient" (source: authors' simulation based on [68] and R output (Biblioshiny)).

The 2020–2022 thematic evolution, as shown in Figure 10b, consists of 11 clusters distributed into four quadrants. First, the quadrant of emerging or declining themes (peripheral/isolated and underdeveloped) has four clusters: halal products have one topic, food additives have one topic, halal detection has two topics, and food consumption has two topics. Second, the quadrant of basic themes (central but underdeveloped) has one cluster: food supply has two topics. Third, the quadrant of niche themes (peripheral/isolated but highly developed) has one cluster: healthy foods have three topics. Fourth, the quadrant of motor themes (central and highly developed) has five clusters: articles and animal processing have 24 topics, human and use/markets have 18 topics, Indonesia and nutritional composition have 6 topics, Muslims and health have 10 topics, and algorithms have 4 topics. The detailed topics are presented in Table A3 (Appendix C).

Figure 10a,b imply some issues. First, the main focus of future research should be on emerging or declining and basic themes. In this case, the clusters in emerging or declining and basic themes in Figure 10b should be the focus because they need to be addressed by many scholars. The niche quadrant is strategic but needs to be more relevant because it covers rabbit feeds. Second, the topics in the four quadrants are dynamic because some topics in quadrant one can diverge from or converge with other quadrants, changing the importance of the topics (strategic or non-strategic status). For example, the topic of halal products in the cluster of additives and business (niche themes in 1999–2019) changed to the cluster of halal products (declining themes in 2020–2022). The halal product falls into declining themes because it failed to move to motor themes and is also a familiar theme (emerging themes). The other example is the topic of commerce in the cluster of additives and business (niche themes in 1999–2019), which changed to the cluster of human and use/markets (motor themes in 2020–2022). A description of the dynamics of the topics is presented in Table 6.

Table 6. Topic dynamics from period 1 (1999–2019) to period 2 (2020–2022).

Common Words/Topics in Period 1 and Period 2	Change in Clusters' Topics (Quadrant)	
	From Period 1 (1999–2019)	To Period 2 (2020–2022)
halal products	additives and business (niche)	halal products (declining or emerging)
commerce	additives and business (niche)	human and use/market (motor)
animals; polymerase chain reaction; animal; nonhuman; pig; cattle; mammals	animal origins and market(motor)	article and animal processing (motor)
Islam; gelatin; Malaysia; chicken; review	animal origins and market (motor)	human and use/market (motor)
meat	animal origins and market (motor)	Indonesia and nutritional composition (motor)
article	article and demographic condition (motor)	article and animal processing (motor)
human; humans	article and demographic condition (motor)	human and use/market (motor)
religion; drug industry; Muslim	Article and demographic condition (motor)	Muslim and health (motor)
food analysis; controlled study; high performance liquid chromatography	food analysis (motor)	article and animal processing (motor)
certification	food analysis (motor)	Muslim and health (motor)
food ingredients	food products (basic)	article and animal processing (motor)
food additives	food products (basic)	food additives (declining)
priority journal	food quality (basic)	Muslim and health (motor)
proteins	gel strengths (motor)	halal detection (declining or emerging)

Source: the authors' simulation based on [68] and R output (Biblioshiny).

The previous discussion raises some questions: why did some topics undergo declines in scientific publications? Why is there only one cluster in the niche quadrant in 2020–2022? What are the topics in social sciences related to the field of study of business and economics? The answer to the first and second questions is the same because high-quality research is rare and the publications considering the topics are very few. Moreover, the citations of papers discussing the topics still need to be improved. The last question is answered by the fact that words of social sciences in the clusters sometimes mean that those clusters include economics and business study fields. The papers with the keywords of halal of haram additives and ingredients are mainly in the natural sciences, agricultural sciences, health sciences, and disciplines other than social sciences, as described in Table 7. That is why the focus of future studies on halal or haram additives and ingredients should also cover of the clusters of motor themes in Figure 10b. Thus, a future research priority in economics and business should be to consider three out of the four quadrants in Figure 10b.

Table 7. Selected contributors and coverage of thematic evolution 2020–2022: Keyword "Halal or Haram Additive/Ingredient".

Quadrant	Cluster	Source (Quartile)	Title	Total Citation	Remarks
Declining or Emerging	food additives	[93] (Q4)	Bill of Material Analysis Framework of Food Menu to Increase Raw Material Inventory Efficiency and Halal Food Inspection of Culinary Business	1	Non-Soc Science (Logistics)
	halal detection	[94] (-)	Designing R-Cnn Algorithm to Detect Halal Composition of Korean Food and Beverages	0	Non-Soc Science
		[95] (Q2)	Adoption of Analytical Technologies for Verification of Authenticity of Halal Foods–A Review	0	Non-Soc Science
	food consumption	[96] (Q4)	Trends in the Development of Combined Foods to Create Functional Foods	0	Non-Soc Science
		[97] (Q3)	5R-Based Character Strengthening Model to Support Halal Aquaculture Industry Practitioners Through Good Water Quality Management and Safe Machinery Operation	0	Non-Soc Science
Motor	human and use/ market	[98] (Q2)	A Systematic Review on the Skin Whitening Products and Their Ingredients for Safety, Health Risk, and the Halal Status	9	Non-Soc Science
		[99] (Q4)	Preparation and Characterization of Coconut Oil-Based Soap with Kaolin as Filler	6	Non-Soc Science
		[100] (Q1)	Cell-Based Influenza Vaccine: Current Production, Halal Status Assessment, and Recommendations towards Islamic-Compliant Manufacturing	4	Non-Soc Science
		[101] (Q2)	A Systematic Literature Review on the Current Detection Tools for Authentication Analysis of Cosmetic Ingredients	2	Non-Soc Science (Cosmetics)

Table 7. *Cont.*

Quadrant	Cluster	Source (Quartile)	Title	Total Citation	Remarks
		[102] (Q3)	Religion and Cosmetics: Guidelines for Preparing Products Aimed at the Muslim World Based on the Interpretation of Halal Cosmetics in Malaysia	0	Social Sciences (Cosmetics)
		[103] (Q3)	Consumer Rights in Halal Products: A Study Based on Legal and Syariah Perspectives	0	Social Sciences/Business
	Indonesia and nutritional composition	[104] (Q3)	Potential Application of Grey Oyster Mushroom Stems as Halal Meat Replacer in Imitation Chicken Nuggets	7	Non-Soc Science
		[105] (Q4)	Development And Evaluation of Polyherbal Halal Ointment Using Honey and Papaya	5	Non-Soc Science
		[106] (Q3)	Analysis of Cocktail Honey Content as a Supplementary Preparation in Preconception Women	0	Non-Soc Science
	Muslim and health	[107] (Q1)	Understanding COVID-19 Halal Vaccination Discourse on Facebook and Twitter Using Aspect-Based Sentiment Analysis and Text Emotion Analysis	1	Social Sciences
		[108] (Q2)	Rapid Discrimination of Halal and Non-Halal Pharmaceutical Excipients by Fourier Transform Infrared Spectroscopy and Chemometrics	1	Non-Soc Science (Pharma)
		[109] (Q2)	Halal Certification of Patented Medicines in Indonesia in Digital Age: A Panacea for the Pain?	1	Social Sciences (Pharma)
		[110] (Q3)	Issues in Halal Food Product Labelling: A Conceptual Paper	1	Social Sciences/Business
		[111] (Q4)	Everything Halal in the Webshop: Medicines for Muslims without Animal Ingredients [Alles Halal in Webshop]	0	Non-Soc Science (Pharma)
	article and animal processing	[112] (Q1)	Hydroxyproline Determination for Initial Detection of Halal-Critical Food Ingredients (Gelatin and Collagen)	15	Non-Soc Science
		[113] (Q4)	Proteomic Technologies and Their Application for Ensuring Meat Quality, Safety, and Authenticity	2	Non-Soc Science
		[114] (Q3)	Review On Halal Forensic: A Focus on DNA-Based Methods for Pork Authentication	2	Non-Soc Science
		[115] (Q2)	A Novel Chemometrics Method for Halal Authentication of Gelatin in Food Products	1	Non-Soc Science
		[116] (Q3)	Screening Porcine DNA in Collagen Cream Cosmetic Products	1	Non-Soc Science (Cosmetics)
		[117] (Q2)	Determination of Pork Adulteration in Roasted Beef Meatballs Using Fourier Transform Infrared Spectroscopy in Combination with Chemometrics	0	Non-Soc Science

Table 7. *Cont.*

Quadrant	Cluster	Source (Quartile)	Title	Total Citation	Remarks
		[118] (Q2)	Analysis of Lard in Palm Oil Using Long-Wave Near-Infrared (Lw-Nir) Spectroscopy and Gas Chromatography–Mass Spectroscopy (Gc–Ms)	0	Non-Soc Science
		[119] (Q3)	Recent Advanced Techniques in Cysteine Determination: A Review	0	Non-Soc Science
	article and animal processing; halal products	[120] (-)	Named Entity Recognition and Optical Character Recognition for Detecting Halal Food Ingredients: Indonesian Case Study	0	Non-Soc Science
Niche	Healthy feeds	[121] (Q2)	Hepatoprotective and Renoprotective Effects of Silymarin against Salinomycin-Induced Toxicity in Adult Rabbits	0	Non-Soc Science

Source: the authors' simulation based on data from many sources [68,87] and R output (Biblioshiny).

Future Direction

In this section, the authors highlight some of the articles ranked in quartiles 1, 2, and 3 in the Scimago Journal Ranking [87], as presented in Table 7. The selected articles on the food additives and ingredients in the thematic evolution of 2020–2022 (bibliometrix output in R language) can be grouped into the following fields.

The first is the halal detection cluster in the emerging or declining quadrant. Ref. [95] carried out a study on potential halal verification methods to deal with halal integrity and to ensure the use of pure halal ingredients in the food industry. They compared the benefits and limitations of old and new halal authentication methods [95]. The second is the consumption cluster within the emerging or declining quadrant. Ref. [97] conducted a review of the social and technical perspectives of improving water quality and facility operation in supporting halal-tayyib aquaculture and suggested some solutions for better water quality and facility management.

The third is the human and use/market cluster within the motor quadrant. Ref. [103] performed a study on consumer rights with regard to the halal logo, product origins and ingredients, and integrity under legal and sharia (Islamic Law) perspectives. They found that consumer rights are protected by formal law and should be aligned with sharia (Islamic law) [103]. The fourth is Indonesia and the nutritional composition cluster within the motor quadrant. For example, [104] performed an experimental study on grey oyster mushrooms and found that halal meat can be substituted with the mushroom as the food ingredient in the production of imitation chicken nuggets. Ref. [106] performed a study on the role of the ingredient composition of a halal honey cocktail in improving the reproductive health and nutrition of pre-conception women and found that the supplement was suitable and safe for human consumption. The fifth is the Muslim and health cluster within the motor quadrant. Ref. [110] reviewed issues of Islamic and halal labels in food products and found the misuse of Islamic attributes in halal products as an unethical marketing strategy.

The sixth is the article and animal processing cluster within the motor quadrant. Ref. [112] investigated a signature amino acid for gelatin and collagen (hydroxyproline) to detect the contamination by non-halal foodstuffs in food products. They found that hydroxyproline can be used as the primary screening tool to detect animal-based gelatin and collagen in several food products for halal certification [112]. Ref. [114] conducted a review on methods to detect porcine DNA amidst the adulteration of foods, and they found that the "DNA-based method" was recommended to use in halal food authentication. Ref. [115] conducted a study on "novel chemometrics methods" using the Fuzzy Autocatalytic Set

(FACS) to determine Fourier Transform Infrared (FTIR) spectra to detect halal gelatin, and they found that the gelatins were identifiable because they had different characteristics. Ref. [117] performed a study on detecting a mixture of pork (a disallowed ingredient) in meatballs using a combination of Fourier Transform Infrared (FTIR) spectroscopy methods and chemometrics. They found that the methods were reliable in detecting adulteration by non-halal ingredients in halal food [117]. Ref. [118] performed a study on technologies to detect adulteration by lard (animal fats as disallowed ingredients from pig) in palm oil (as a halal ingredient). They demonstrated that the methods successfully detected lard adulteration in palm oil [118]. Ref. [119] reviewed the use and effect of cysteine (one type of food additive), emphasizing halal issues, toxicity, and analytical approaches in the identification of the compounds of cysteine.

The papers in the clusters above are technical. Under the food system framework in Figure 11, most of the papers support components of innovation, technology, and infrastructure drivers. Therefore, this study proposes new research areas on halal food additives and ingredients in economics and business. The research areas should consider other components in the food system framework (Figure 11), considering but not limited to the following topics.

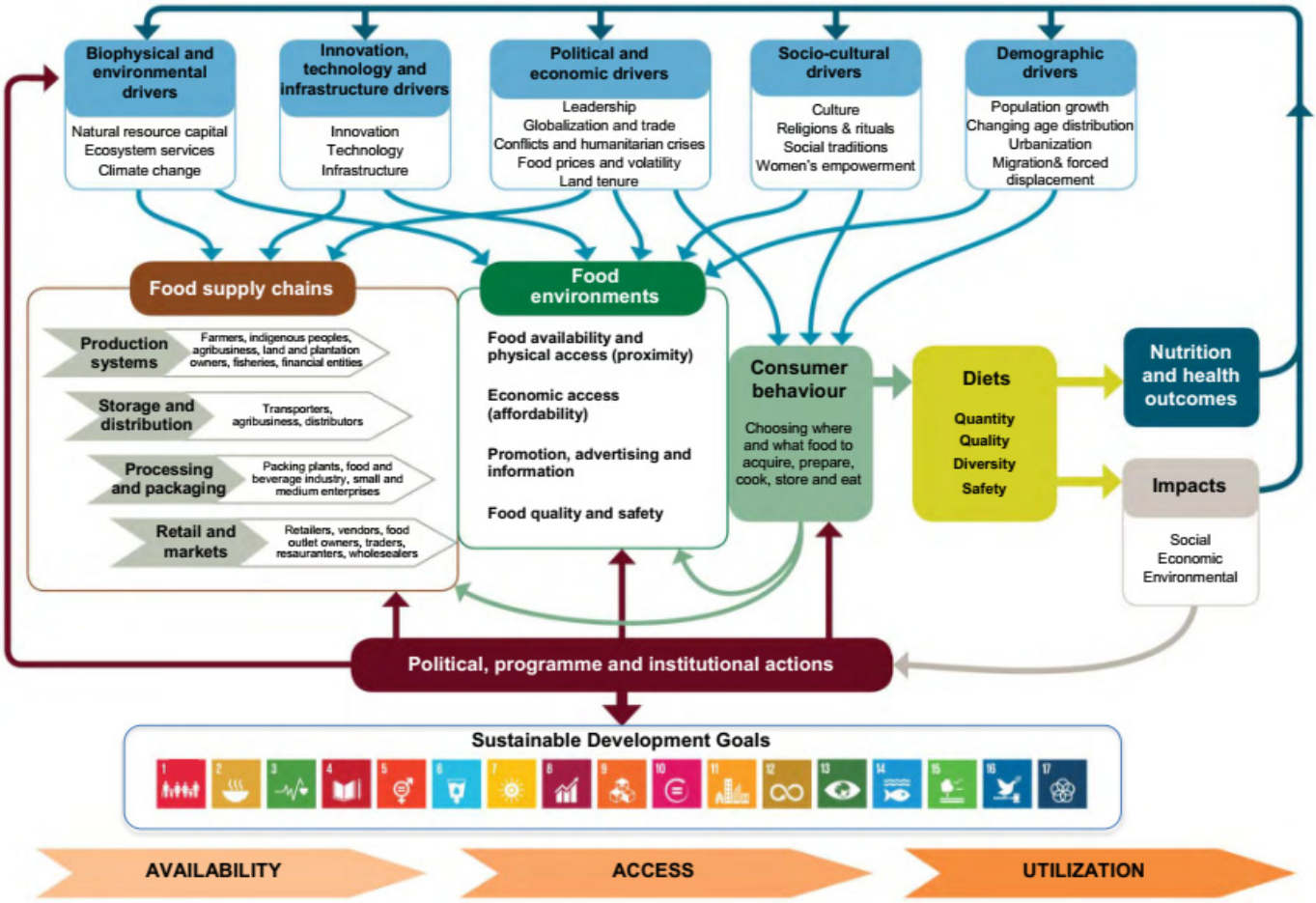

Figure 11. The framework of the food system for diets and nutrition [59].

The first is ethical and sustainable sourcing. Ethical sourcing is "sourcing the material, products, and services that organizations demand from their suppliers in an ethical and socially responsible way," while sustainable sourcing is "sourcing the material, products, and services that organizations demand from their suppliers in a sustainable manner" [122]. Ethical and sustainable sourcing is drawn from the generalization of the papers under the food topics implying adulteration behavior in halal production [112,114,117,118]. The other

possibility is a lack of halal integrity from farm to fork due to poor halal knowledge and poor capabilities in halal protection [123,124]. The integrity of the halal supply chain from farm to fork supports the food supply chain and food environment under the food system framework (Figure 11). Future research on halal additives and ingredients should address ethical and sustainable sourcing in the supply chain. Ref. [125] suggest that ethical and sustainable sourcing can be evaluated using social accounting techniques.

The second is responsible consumption and consumer sovereignty. It aligns with goal 12 (ensuring sustainable consumption and production patterns) of the SDG.s [12]. Responsible consumption is understood in two ways: first, conscious consumption is a "holistic understanding of consumption involving environmental, social, health, political, and value dimension", and second, "mindful consumption is consumer behavior where the individual demonstrates a compassion toward oneself, others, and the environment and is aware of his/her consumption patterns while adopting new approaches in reduction of one's consumption" [126]. The definition aligns with the food system framework's three components (food environment, consumer behavior, and diet) in Figure 11. The components align with halal diets and an effort to avoid the harmful effects of the overconsumption of food additives and ingredients, as presented in Table 2. The factors affecting the consumption patterns are as follows: expenditure, poor knowledge of lifestyle, ignorant mentality, the business of advertisement, habits, convenience, availability, social expectation, sociopsychological factors (desire for happiness and well-being), regulation, and culture [126]. Thus, future research areas in halal should address the two components of the food system frameworks and the factors affecting consumption patterns.

Regarding the ethical issues of halal-related businesses [103,110], halal marketing should consider "consumer sovereignty" as its marketing basis, as suggested by [127]. Consumer sovereignty has three dimensions, as follows: capability (vulnerability and freedom of choice), information (availability and quality), and third choice (opportunity to switch to other suppliers) [127].

The third is international trade and other topics in economics and business. Future research in the international trade of halal food supports the political and economic drivers of food system sustainability under the food system framework (Figure 11). Some additives and ingredients require high technologies [46,81], which are primarily produced in developed economies. This is relevant to the Heckscher–Ohlin trade model, which argues that trade occurs among countries having "the abundant and scarce supply of capital-intensive production factors" [128,129].

Moreover, studies on halal or haram additives and ingredients can also be approached through economic models. One of the economic models is computable general equilibrium, enabling the model of halal demand, production, and trade [130–132]. Further studies on halal additives and ingredients in business and economics can address food security issues [12,54,92] to achieve the goal of zero hunger according to the SDGs (U.N., 2022). The other potential study to be conducted in the future is an interplay between sustainable foods and the green/sustainable supply chain [133–135] under the halal perspective [7,29,65,124]. The research on sustainable supply chains also supports components of the food supply chain and food environment under the food system framework (Figure 11).

4. Conclusions

This study investigates the research gap in the halal sector. This paper has some conclusions regarding the analysis of the keyword "halal or haram additive and ingredient". First, most published sources and local citations come from Western countries (supply side of halal goods). In contrast, the author affiliations mostly come from Muslim countries (supply and demand side of halal goods).

Second, because the VOSviewer output of co-occurrence analysis demonstrates the neglected topics in some clusters (i.e., cluster 1: production-consumption and supply chain; cluster 4: healthy foods; and cluster 5: logistics-market and health effects), and the strategic diagram of the 2020–2022 thematic evolution demonstrates a research gap in three out

of the four quadrants (i.e., emerging or declining, basic, and motor themes), the future studies on halal additives and ingredients in food sectors should pay attention to the field of economics and business.

In line with the VOSviewer output, the bibliometrix output implies potential research areas in halal food additives and ingredients: ethical and sustainable sourcing, responsible consumption, consumer sovereignty, international trade, economic modeling, food security, and a green/sustainable supply chain. Even if the VOSviewer output in cluster 2 concerning market and control/regulation is a concern for many scholars, halal regulation has a persistent need to be studied because it is related to international trade, as prescribed by Krugman and colleagues [128], and food safety [60].

This study therefore confirms the importance of previous bibliometric studies on the halal supply chain conducted by some scholars [37–41]. This study also confirmed the importance of further studies on the interplay among SDG.s, food sustainability, sustainable production, and consumption, as prescribed by some institutions [12,54,59].

Our research certainly has limitations. This study only analyzes the keyword "halal OR haram AND ingredient OR additive" without additional keywords because our search results on the Scopus database showed that the keywords provided good articles. Before analyzing the result, the authors tried to add some additional keywords. However, the authors found a limited number of articles (less than 100 and even less than 50) on the Scopus database.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15075680/s1.

Author Contributions: Conceptualization, L.O.N., B.GY. and M.F.-F.; methodology, L.O.N. and Z.L.; software, L.O.N.; validation, B.GY., M.F.-F. and Z.L.; formal analysis, L.O.N.; investigation, L.O.N.; resources, L.O.N.; data curation, L.O.N.; writing—original draft preparation, L.O.N.; writing—review and editing, L.O.N., B.GY., M.F.-F. and Z.L.; visualization, L.O.N.; supervision, B.GY., M.F.-F. and Z.L.; project administration, B.GY., M.F.-F. and Z.L.; funding acquisition, B.GY., M.F.-F. and Z.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data used in the analysis can be downloaded from the Scopus database (https://www.scopus.com/search/form.uri?display=basic&zone=header&origin=#basic), accessed on 15 December 2022.

Acknowledgments: We thank the Hungarian University of Agriculture and Life Science, and Stipendium Hungaricum (Tempus Public Foundation) for their support to this research. We also thank Setiawan Priatmoko, Nuha Desi Anggraeni, Muhammad Imam Ma'ruf, and Deni Pandu Nugraha for their feed-back and contribution. Lastly, we also thank the editor and the anonymous reviewers for their insightful and constructive comments.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. List of topics in co-occurrence analysis (VOSviewer output).

Cluster	Keyword	Occurrences	Total Link Strength
Cluster 1 (Red): Production, Consumption, and Supply Chain	halal	49	236
	Malaysia	13	81
	food products	11	81
	food industries	9	60
	food additives	8	58
	standards	5	53
	halal products	8	48
	food ingredients	6	47
	Indonesia	6	47
	commerce	6	42
	halal food	8	41
	food supply	4	35
	halal certification	10	33
	additives	7	33
	food safety	8	29
	food production	4	29
	ingredients	4	28
	food processing	4	27
	haram	5	24
	chemical contamination	3	24
	fermentation	3	24
	organic solvents	3	23
	food consumption	3	20
	marketing	3	20
	ontology	3	20
	bakery products	6	19
	medicine	3	19
	accreditation	2	19
	optical character recognition	5	18
	food quality	3	18
	processed foods	3	18
	global business	2	18
	halal industries	2	18
	heterogeneous information	2	18
	indicators (chemical)	2	18
	biotechnology	4	16
	genetic engineering	2	16

Table A1. *Cont.*

Cluster	Keyword	Occurrences	Total Link Strength
	purchase intention	5	15
	mobile computing	3	15
	nutrition	3	15
	enzymes	2	15
	graph algorithms	2	14
	graph-based algorithms	2	14
	graphic methods	2	14
	process discovery	2	14
	process modeling	2	14
	blood	3	13
	mobile applications	3	13
	critical control points	2	12
	halal standards	2	12
	health	3	11
	food microbiology	2	11
	genes	2	11
	microorganisms	2	11
	vinegar	2	11
	ethics	3	10
	bakeries	2	10
	cosmetic products	2	10
	surveys	3	9
	allergies	2	9
	halal and kosher foods	2	9
	halal market surveillance	2	9
	Malaysians	2	9
	plasma protein	2	9
	sales	2	9
	surimi-based product	2	9
	tayyib	2	9
	polymerase chain reaction (PCR) Southern hybridization	2	9
	Android (operating system)	2	8
	Android applications	2	8
	bakery and confectionery	2	8
	Capra hircus	2	8
	frozen food	2	8
	halal verification	2	8
	Ishihara	2	8

Table A1. *Cont.*

Cluster	Keyword	Occurrences	Total Link Strength
	non-halal product	2	8
	quantitative approach	2	8
	supply chains	2	8
	computer programming	2	7
	food applications	2	7
	water quality	3	6
	oils and fats	2	5
	food-grade lubricants	2	4
	Japanese foods	2	4
	animal feed	2	3
	cosine similarity	2	3
	theory of planned behavior	2	3
	halal supply chain	3	2
	halal industry	2	2
Cluster 2 (Green): Market and Control/ Regulation	article	26	321
	human	23	283
	nonhuman	13	161
	humans	10	155
	Islam	12	148
	religion	6	77
	Muslim	9	73
	review	7	73
	cosmetic	8	71
	attitude	7	61
	certification	6	59
	perception	5	57
	cosmetics	5	54
	drug industry	4	50
	priority journal	5	48
	questionnaire	3	48
	chicken	4	44
	unclassified drug	4	40
	Malaysian	3	39
	attitude to health	3	36
	chemometric analysis	2	34
	vaccination	3	33
	chemical analysis	2	33
	government	2	33
	knowledge	4	32

Table A1. *Cont.*

Cluster	Keyword	Occurrences	Total Link Strength
	quality control	3	32
	skin	2	32
	consumer	4	31
	pharmaceuticals	3	31
	decision making	2	30
	cross-sectional study	2	29
	demography	2	29
	consumer attitude	2	27
	systematic review	2	27
	Fourier transform infrared spectroscopy	3	26
	kap	2	26
	moisture	2	26
	Pakistan	4	25
	halal vaccine	2	25
	vaccine	2	25
	safety	3	24
	algorithm	2	23
	ethanol	5	22
	product safety	2	22
	vaccine production	2	22
	human experiment	2	21
	stearic acid	2	21
	partial least squares regression	2	20
	practice guideline	2	20
	halal cosmetics	3	19
	religiosity	3	18
	magnesium stearate	2	18
	pH	3	17
	skin irritation	2	17
	theory of reasoned action	2	16
	halal pharmaceuticals	2	15
	physical chemistry	2	15
	chemical composition	2	14
	consumer protection	2	14
	Aspergillus oryzae	2	13
	carbohydrate	2	13
	COVID-19	2	13
	drug formulation	2	13
	vaccines	2	13

Table A1. *Cont.*

Cluster	Keyword	Occurrences	Total Link Strength
	willingness to pay	2	13
	Muslim consumers	6	11
	honey	2	10
	brand	4	9
	alcohol	2	9
	Islamic Law	2	9
	purchase behavior	3	8
	Western imported food	3	6
	education	2	5
	Muslim consumer	2	5
	Saccharomyces cerevisiae	2	5
	awareness	2	4
	detection	2	4
	trust	2	4
Cluster 3 (Blue): Detailed Types, Raw Materials, and Their Productions	animals	16	208
	gelatin	17	157
	meat	11	151
	animal	9	150
	pig	8	121
	swine	6	119
	food analysis	7	116
	controlled study	7	100
	polymerase chain reaction	9	89
	bovine	5	89
	fish	6	76
	procedures	4	74
	cattle	4	73
	principal component analysis	6	72
	high-performance liquid chromatography	5	67
	chemistry	4	67
	mammals	4	63
	collagen	4	62
	DNA	4	56
	porcine	4	55
	chemometrics	8	53
	food packaging	5	52
	analytical method	3	50
	amino acid	3	46
	DNA isolation	2	46

Table A1. *Cont.*

Cluster	Keyword	Occurrences	Total Link Strength
	food handling	3	45
	gene amplification	3	45
	infrared spectroscopy	3	45
	meat products	3	42
	sus	4	41
	food composition	2	41
	bovinae	3	40
	authentication	7	39
	meats	4	38
	DNA extraction	2	35
	food contamination	3	34
	extraction	4	33
	conventional PCR	2	32
	species-specific primers	2	32
	limit of quantitation	2	31
	fishes	2	30
	pharmaceutical products	2	30
	spectroscopy, Fourier transform infrared	2	30
	food industry	4	28
	DNA denaturation	2	27
	DNA polymerase	2	27
	DNA sequence	2	27
	real-time polymerase chain reaction	2	27
	halal authentication	4	26
	limit of detection	2	25
	pork	2	25
	process optimization	2	25
	proteins	4	24
	adulteration	2	23
	food markets	2	23
	food labeling	2	21
	gels	2	21
	kosher	4	16
	amino acids	2	16
	mass spectrometry	3	15
	gellan	2	15
	FTIR spectroscopy	3	14
	protein contents	2	14
	Animalia	2	13
	chains	2	13

Table A1. *Cont.*

Cluster	Keyword	Occurrences	Total Link Strength
	gel strengths	2	12
	gelation	2	12
	lard	2	11
	pharmaceutical industry	2	8
	proteomics	2	8
	real-time PCR	2	8
	chromatography	2	7
	multivariate calibration	2	7
	meatballs	2	6
	viscosity	2	5
	nanotechnology	2	4
	halal product	2	3
Cluster 4 (Yellow): Healthy foods	adult	6	89
	male	5	81
	female	4	69
	diet	3	63
	ethnology	2	49
	middle-aged	2	41
	statistics	2	41
	caloric intake	2	34
	feeding behavior	2	34
	food habits	2	34
	red meat	3	30
	vegetables	2	29
	taste	2	27
	body weight	2	26
	major clinical study	2	26
	risk factor	2	22
	food culture	2	21
	protein	2	21
	biological marker	2	19
	cholesterol	2	17
	antioxidant	3	16
	milk	2	12
	active pharmaceutical ingredients	3	4
	carotenoid	2	3
	carotenoids	2	3
	tourism	3	1

Table A1. *Cont.*

Cluster	Keyword	Occurrences	Total Link Strength
Cluster 5 (Purple): Logistics, market and Health Effects	food	12	73
	air pollution	3	21
	air quality	3	21
	Makkah	3	21
	Saudi Arabia	3	21
	atmospheric modeling	2	18
	atmospheric pollution	2	18
	concentration (composition)	2	18
	generalized additive model	2	18
	Makkah [Saudi Arabia]	2	18
	health risk	3	14
	particulate matter	2	13
	halal logistics	3	11
	Islamic logistics	2	9
	beverages	2	8
	halal detection	2	8
	Ingredient	2	8
	halal market	2	7
	beverage and ingredient companies	2	6
	halal information	2	6
	halal logo	3	5
	halal awareness	2	5

Source: the authors' calculations based on [68] and VOSviewer thesaurus.

Appendix B

Table A2. Thematic map for period 1999–2019 (output of R language/Bibliometrix).

Quadrant	Cluster Label	Words/Topics	Occurrences
Basic themes	food products	food products	8
		food additives	5
		extraction	3
		food ingredients	3
		amino acids	2
		Animalia	2
		chains	2
	food quality	food quality	3
		food safety	3
		priority journal	3
		process optimization	2

Table A2. *Cont.*

Quadrant	Cluster Label	Words/Topics	Occurrences
Emerging or declining themes	water quality	water quality	2
	food-grade lubricants	food-grade lubricants	2
	oils and fats	oils and fats	2
	chromatography	chromatography	2
	Ethanol	ethanol	2
Motor Themes	halal and food industries	halal	10
		food industries	8
		food processing	4
		food production	4
		haram	3
		processed foods	3
		biotechnology	2
		enzymes	2
		fermentation	2
		frozen food	2
		genes	2
		halal and kosher foods	2
		microorganisms	2
	article and demographic condition	article	14
		human	12
		adult	5
		female	4
		humans	7
		diet	3
		male	4
		middle-aged	2
		religion	4
		attitude to health	3
		Malaysian	3
		questionnaire	3
		red meat	2
		taste	2
		caloric intake	2
		consumer attitude	2
		cross-sectional study	2
		demography	2
		drug industry	2
		ethnology	2
		feeding behavior	2
		food habits	2

Table A2. *Cont.*

Quadrant	Cluster Label	Words/Topics	Occurrences
		Muslim	2
		Pakistan	2
		partial least squares regression	2
		perception	2
		statistics	2
	gel strengths	gel strengths	2
		gelation	2
		protein contents	2
		proteins	2
	origins and market	Islam	7
		meat	8
		animals	10
		gelatin	4
		polymerase chain reaction	5
		Malaysia	6
		swine	5
		animal	6
		food handling	3
		DNA	3
		Fish	4
		meat products	3
		nonhuman	4
		standards	4
		bovinae	2
		bovine	2
		food packaging	3
		meats	3
		Pig	3
		principal component analysis	2
		sus	3
		authentication	2
		cattle	2
		chicken	2
		fishes	2
		food markets	2
		gels	2
		mammals	2
		review	2
		vegetables	2

Table A2. *Cont.*

Quadrant	Cluster Label	Words/Topics	Occurrences
	food analysis	food analysis	5
		certification	3
		chemistry	3
		chemometrics	2
		controlled study	3
		food contamination	2
		high-performance liquid chromatography	3
		infrared spectroscopy	3
		organic solvents	3
		procedures	3
		spectroscopy, Fourier transform infrared	2
niche themes	mobile computing	mobile computing	3
		optical character recognition	3
		allergies	2
		Android (operating system)	2
		Android applications	2
		mobile applications	2
	bakery products	bakery products	3
		surveys	3
		bakeries	2
		quantitative approach	2
	additives and business	additives	3
		chemical contamination	3
		commerce	3
		halal products	3
		global business	2
		halal industries	2
		heterogeneous information	2
		indicators (chemical)	2
		ontology	2

Source: The authors' simulation based on [68] and R output (Biblioshiny).

Appendix C

Table A3. Thematic map for period 2020–2022 (output of R language/Bibliometrix).

Quadrant	Cluster	Words/Topics	Occurrences
Basic themes	food supply	food supply	3
		food microbiology	2
Emerging or declining themes	food additives	food additives	2
	halal products	halal products	2
	halal detection	halal detection	2
		proteins	2
	food consumption	food consumption	2
		nutrition	2
Motor themes	article and animal processing	article	12
		nonhuman	9
		animals	6
		collagen	3
		controlled study	4
		animal	3
		chemometric analysis	2
		food analysis	2
		pig	3
		amino acid	2
		cattle	2
		DNA denaturation	2
		DNA polymerase	2
		DNA sequence	2
		food ingredients	2
		Fourier transform infrared spectroscopy	2
		FTIR spectroscopy	2
		gene amplification	2
		high-performance liquid chromatography	2
		limit of detection	2
		mammals	2
		moisture	2
		polymerase chain reaction	2
		real-time polymerase chain reaction	2
	human and use/markets	human	11
		gelatin	4
		cosmetic	4
		Islam	3

Table A3. *Cont.*

Quadrant	Cluster	Words/Topics	Occurrences
		review	5
		cosmetics	4
		Malaysia	3
		commerce	3
		consumer	3
		humans	3
		unclassified drug	3
		chemical analysis	2
		chicken	2
		decision making	2
		quality control	2
		skin irritation	2
		systematic review	2
		vaccine production	2
	Indonesia and nutritional composition	Indonesia	5
		honey	2
		carbohydrate	2
		meat	2
		pH	2
		physical chemistry	2
	Muslim and health	Muslim	6
		vaccination	2
		vaccine	2
		algorithm	2
		certification	2
		drug industry	2
		medicine	2
		practice guideline	2
		priority journal	2
		religion	2
	Algorithms	graph-based algorithms	2
		graph algorithms	2
		graphic methods	2
		process modeling	2
Niche themes	Healthy feeds	cholesterol	2
		protein	2
		risk factor	2

Source: the authors' simulation based on [68] and R output (Biblioshiny).

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