İstanbul Zaim Üniversitesi
HELAL VE ETİK ARAŞTIRMALAR DERGİSİ JOURNAL OF HALAL AND ETHICAL RESEARCH
https://dergipark.org.tr/tr/pub/head

MAINTAINING TRACEABILITY IN HALAL FOOD PRODUCTION WITH THE USE OF ARTIFICIAL INTELLIGENCE AND BLOCKCHAIN

Ali BATU*

Emekli Öğretim Üyesi (Prof. Dr.) Gıda ve Gastronomi Bilimi Uzmanı, Gastro Food Academy, Antalya, Türkiye

MAKALE BİLGİSİ

Geliş tarihi: 17 Ağustos 2024
Düzeltme tarihi: 24 Aralık 2024
Kabul tarihi: 31 Aralık 2024

Keywords:
Halal food, artificial intelligence blockchain, supply chain, halal traceability

ABSTRACT

The demand for halal food products has been on the rise in recent years and is expected to continue growing in the near future. Consequently, the importance of factors such as Halal certification, Halal standards, and Halal traceability is becoming more prominent. Halal traceability is essential for ensuring that Halal food production is conducted correctly. It guarantees product quality throughout the supply chain and verifies product identity to protect consumers. Halal traceability also helps boost consumer confidence in food safety. Furthermore, the implementation of Halal traceability can reduce the costs associated with product recalls. Reducing product recalls, particularly in terms of Halal assurance, enhances customer trust in the integrity of the Halal sector. Techniques such as Blockchain and artificial intelligence have become widespread in supply chain tracking. As a result, maintaining the integrity of the Halal food supply chain has become much managable. The Halal food supply chain is complex and faces many challenges that can affect food safety and quality. From the sourcing of food ingredients to final production and distribution, there are numerous points where contamination can occur. Therefore, ensuring that Halal food meets the highest safety and quality standards is vital. Artificial intelligence in Halal food safety is important for increasing accuracy and efficiency, enhancing traceability and transparency, and providing real-time monitoring and analysis. Additionally, artificial intelligence can provide predictive capabilities to prevent contamination, facilitate the certification process, and offer valuable insights into the Halal food industry. This paper aims to explore how Halal food auditing works, the importance of food traceability systems, the need for traceability implementation in food supply chains, and the critical role it plays in ensuring safety and quality within food supply chains.

Anahtar Kelimeler:
Helal gıda, yapay zeka blok zinciri, tedarik zinciri, helal izlenebilirlik

YAPAY ZEKA VE BLOKZİNCİR KULLANIMI İLE HELAL GIDA ÜRETİMİNDE İZLENEBİLİRLİĞİN SÜRDÜRÜLMESİ

ABSTRACT

Helal gıda ürünlerine olan talep son yıllarda artış göstermektedir ve yakın gelecekte de bunun artmaya devam etmesi beklenmektedir. Bu yüzden, Helal sertifikasyonu, Helal standartları ve Helal izlenebilirliği gibi faktörlerin önemi daha da belirginleşmektedir.

***Sorumlu Yazar:** Ali BATU, **E-mail:** alibatu42@gmail.com **Orcid:** https://orcid.org/0000-0003-3628-7747

Helal izlenebilirliği, Helal gıda üretiminin doğru bir şekilde yürütülmesini sağlamak için esastır. Tedarik zinciri boyunca ürün kalitesini garanti eder ve tüketicileri korumak için ürün kimliğini doğrular. Helal izlenebilirliği ayrıca tüketicilerin gıda güvenliğine olan güvenini artırmaya yardımcı olur. Dahası, Helal izlenebilirliğinin uygulanması ürün geri çağırmalarıyla ilişkili maliyetleri azaltabilir. Özellikle Helal güvencesi açısından ürün geri çağırmalarını azaltmak, müşterilerin Helal sektörünün bütünlüğüne olan güvenini artırır. Blockchain ve yapay zeka gibi teknikler, tedarik zinciri takibinde yaygın olarak kullanılmaya başlanmış ve bu sayede de Helal gıda tedarik zincirinin bütünlüğünün korunması çok daha kolay bir hale gelmiştir. Helal gıda tedarik zinciri, oldukça karmaşıktır ve gıda güvenliğini ve kalitesini etkileyebilecek birçok zorlukla karşı karşıyadır. Gıda bileşenlerinin tedarikinden nihai üretim ve dağıtıma kadar, gıda kontaminasyonlarında meydana gelebilecek birçok bulaş noktası vardır. Bu nedenle, Helal gıdanın en yüksek güvenlik ve kalite standartlarını karşılamasını sağlamak hayati önem taşır. Yapay zekanın Helal gıda güvenliğinde kullanımı, doğruluk ve verimliliği artırması, gıda izlenebilirliği ve şeffaflığını geliştirmesi ve gerçek zamanlı izleme ve analiz gibi birçok fayda sağlaması açısından önemlidir. Ek olarak yapay zeka, kontaminasyonu önlemek, sertifikasyon sürecini kolaylaştırmak ve Helal gıda endüstrisine değerli içgörüler sunmak için önemli yetenekler sağlayabilir. Bu makale, Helal gıda denetiminin nasıl çalıştığını, gıda izlenebilirlik sistemlerinin önemini, gıda tedarik zincirlerinde izlenebilirlik uygulamasına duyulan ihtiyacı ve gıda tedarik zincirlerinde güvenliği ve kaliteyi sağlamada oynadığı kritik rolü incelemeyi amaçlamaktadır.

1. Introduction

Consumer rights are universal, and consumers have the right to obtain information about the food and other products they consume. This is because the food consumed can potentially affect people's (individual's) mental and physical health, whether it complies with their religious beliefs and even the health of future generations. Consumers demand the elimination of uncertainty to make the right product choices. In addition to basic criteria such as hygiene, safety, quality, protection, and cleanliness, it is also important for products to comply with religious beliefs (Batu, 2012a). Therefore, there is a demand for a Halal certification system that determines the compliance of food products with religious beliefs. This consumer demand is related to the desire for assurance that the goods and services purchased are reliable in terms of health, environment, and faith. This demand is a natural requirement of the right to be informed. It is crucial for food labels to be complete and understandable, ensuring that foods are suitable for health and compliant with religious beliefs (Akgündüz, 2012). The right to obtain a Halal certificate is based on this universal principle and applies to all citizens, regardless of their religious beliefs or other characteristics (Çelen, 2010b).

Today's rapidly advancing food technology holds significant importance for food additives, which are crucial for public nutrition. Various chemical compounds are added to foods to enhance their appearance, taste, smell, aroma, and flavor, prevent spoilage, and extend shelf life. These added substances are known as food additives (Atman, 2004). With the increase in imports, even basic traditional food items such as leavened bread have come to be produced with additives, leading to a loss of authenticity (Batu, 2012b). However, society generally lacks sufficient knowledge about the many additives used in the production of staple foods like bread. Food additives are closely related to concerns about their Halal status and health implications. Fruit and vegetable products are considered Halal as long as they are not contaminated with Haram additives or contain harmful substances. However, there is a lack of clarity regarding widely used

questionable additives such as gelatin, glycerin, emulsifiers, enzymes, hormones, alcohol, animal fat and protein, flavorings, and sweeteners (Riaz and Chaudry, 2004). The use of such additives in food production raises debates about the Halal status of these products (Batu, 2012a, b). The main issue with food additives is their origins and production methods. They can be derived from pork or pork products, animals not slaughtered according to Islamic principles, or other doubtful sources. Additionally, some food additives are prepared as mixtures of various additives, raising concerns. Globally, Muslims live alongside people of different religious beliefs, leading to significant problems and challenges, particularly concerning food consumption (Sakr, 1988; Riaz and Chaudry, 2004).

The importance of Halal certificate, Halal standards and especially Halal traceability becomes even more important (Zulfakar et al., 2014). Halal traceability ensures product quality throughout the supply chain, allowing for verification and identification of products to protect consumers. This traceability boosts consumer confidence in food safety. Moreover, implementing Halal traceability can reduce costs associated with product recalls. Food producers can apply their own recall management strategies to maintain the safety and Halal status of their products effectively. Reducing product recalls, especially in relation to Halal assurance, will strengthen customer trust in the integrity of the Halal sector (Mohamed et al., 2016). Halal traceability provides detailed information on whether Halal standards are applied. Thus, it allows consumers to verify Halal claims and provides information on whether the product delivered to the customer is Halal and Tayyib (pure and wholesome, healthy, safe, nutritious, and high-quality) (Batu, 2012a, b).

In the later part of the 20th century, the search for Halal food began effectively in countries where Muslims were not the majority. Devout Muslims living in non-Muslim countries have had to strive to find Halal food and beverages for themselves and their families. During these searches, they noticed the Kosher system practiced by Jews. In particular, Muslims in the United States initially preferred Kosher-stamped products because sufficient information about other products was unavailable (Çelen, 2010a). The drive to reduce costs has led to an increase in the use of pork products in production, which has resulted in the widespread use of food additives. Changes in traditional eating habits have increased the consumption of fast food and junk food. Both Muslims and adherents of other religions have sought solutions to combat this negative trend. In this process, devout individuals have believed that new regulations should be made to ensure that the food they consume aligns with their belief systems (Riaz and Chaudry, 2004).

Muslim consumers are concerned about whether products and services comply with Islamic religious requirements. The ability of producers to track processes from start to finish ensures that consumers can trust that all stages of production, processing, and distribution adhere to Islamic rules. The need for devout Muslims to consume Halal-certified foods has emerged. However, it is essential that producers of Halal-certified foods obtain their certifications from reliable firms (Batu, 2012b). For Muslim consumers, Halal is a fundamental requirement when consuming food products. There are suspicions that many additional food ingredients used in products sold by producers are not disclosed (Samsi, Tasnim & Ibrahim, 2011). Halal certification outlines the characteristics that foods prepared according to Islamic

principles should have, the methods of slaughter, the additives to be used in the preparation of these foods, and the properties of the places where these foods are served (Çakır, 2013). Companies must establish a Halal traceability system and be serious about internal and external audits. Consequently, devout individuals within Muslim communities worldwide have believed that foods should go through a specific certification process and have thus established Halal food certification (Batu, 2012b).

Artificial Intelligence (AI) has rapidly become a cornerstone of modern business applications, achieving significant advancements across various sectors. One of the sectors ready for transformation through AI is the global Halal market. The global Muslim population is estimated at approximately 1.8 billion. Therefore, the Halal market stands out as a significant and rapidly growing economic sector. AI can help shape Halal marketing strategies and address and eliminate the challenges and opportunities that may arise. Thus, in the context of Halal marketing, AI can be used to overcome many challenges. Since managing Halal supply chains is quite complex, every step in the supply chain needs to be carefully examined, i.e. monitored, to ensure that products are indeed produced in accordance with Halal. In this process, AI combined with blockchain can help automate checks and identify potential issues. Integrating blockchain and AI to ensure end-to-end compliance in Halal traceability can simplify this process (Ahmed, 2023a).

This article aims to focus on the requirements of a Halal traceability framework for Halal food producers and also to provide the necessary information regarding the traceability of the company's Halal food production. It also aims to identify how Halal food auditing works, the importance of food traceability systems and the critical role they play in ensuring food safety and quality in food supply chains.

2. Methodology

Halal Certification is a conformity assessment process that ensures products and services are produced according to technical standards and Islamic values at every stage, from raw materials to final presentation. It also guarantees that these products are delivered to consumers in a sustainable, halal, and healthy manner through effective traceability. In halal food production, the importance of Halal standards (particularly Halal traceability) has grown alongside Halal certification. Halal traceability plays a crucial role in maintaining product quality across the entire supply chain by enabling product verification and identification, which ensures consumer safety. This process enhances consumer trust in food safety.

Halal Food Traceability encompasses all components involved in the halal food production process, including raw materials, production methods, employees, and the traceability of the final product. The traceability system within the halal food chain should address key factors such as raw material traceability, product processing traceability, input traceability, and the tracking of diseases and residues. This research was conducted through an extensive literature review of scientific journals and various online sources, focusing on keywords such as artificial intelligence, blockchain, supply chain, and halal traceability.

Blockchain and Artificial Intelligence (AI) are two rapidly advancing and widely adopted technologies that have gained traction across various sectors. Although they serve

different purposes, they can be used together to complement each other's strengths. Blockchain, in particular, offers numerous benefits, primarily due to its decentralized structure. It is an advanced database system that enables transparent information sharing across business networks. In this system, data is stored in a chronological order, functioning similarly to an accounting ledger. The technology prevents unauthorized transactions and includes built-in mechanisms to maintain consistency in the shared view of transactions, ensuring high security.

AI-powered solutions can be integrated into existing food safety frameworks to uphold the highest standards of safety and quality in the Halal food supply chain. When applied to Halal food safety, AI enhances accuracy and efficiency, increases transparency, improves traceability, and enables real-time monitoring of verification processes. This technology plays a vital role in optimizing Halal certification procedures, ensuring compliance, and strengthening quality control measures.

3. Halal Certification and Halal Certification Processes

In the context of factory food production, extending the shelf life of food, improving its appearance, maintaining its quality, reducing production costs, and most importantly, achieving high profit margins are the primary goals for many companies. However, for Halal production, all products must be Halal and pure, as commanded by the Quran. The entities responsible for ensuring Halal food production, reducing doubts through their inspections, and providing Halal certification are Halal certifying bodies (Çakır, 2013). A Halal certificate indicates that a product meets Islamic standards. Thus, the Halal certificate serves as a guide for Muslims in choosing food that aligns with their religious values. Besides signifying that a food item is permissible for Muslim consumption, 'Halal' also implies that it is safe and suitable for consumption. Halal certification is a critical factor in boosting consumer confidence that the products they consume are Halal, safe, and clean (Muhamad, Leong, and Isa, 2017).

The Halal food certificate provides an impartial expert service that inspects products, additives, preparation and processing methods, and cleanliness and health conditions within strict safety rules. Additives used in foods that do not have a Halal food certificate are significant in terms of compromising the Halal status of the food. A reliable Halal food certificate provides confidence to the consumer by ensuring the product and producer are recognized and promoted within the global Islamic community. The Halal food certificate, which is decisive for every product that meets Islamic criteria and humanitarian reasons, ensures that both the producer and consumer find common ground. The purpose of using a Halal food certificate is to implement a process where a product is tracked from farm to table. In this process, it is essential that production is carried out according to Islamic rules and within hygienic and health standards (Batu, 2012a).

Halal certification is the responsibility of businesses during the production of their products and is recognized as a key factor influencing purchase intentions. It has been noted that Halal certification serves as a precursor to Halal awareness. The Halal certificate identifies foods permissible for Muslim consumption; therefore, it is essential for both producers and consumers to be aware of the Halal label on products (Jannah and Al-Banna, 2021). For decades, and even longer, Muslims around the world have been misled

by international food-producing companies with non-Halal products being presented as Halal. These products sometimes contained traces of alcohol, allergens, or genetically modified organisms (GMOs). Such products have filled market shelves for years. It is incorrect to exonerate these products merely with a document stating 'Halal.' Therefore, not everyone should be allowed to issue Halal certificates. These certificates should only be issued by firms that have obtained the necessary permissions from officially recognized authorities, have been accredited by international accreditation organizations, and are inspected by the government.

4. Halal Certification Fraud

Halal certification is a critical responsibility of businesses during the production of their products and is considered one of the key factors influencing purchase intentions. It has been noted that Halal certification plays a pioneering role in raising Halal awareness. The Halal certificate identifies foods permissible for Muslims to consume, making it essential for both producers and consumers to be aware of the Halal label on products (Tan, Gligor, and Ngah, 2020). However, the proliferation of Halal certifications has led to a significant issue, as some companies use brand symbols without authorization. Therefore, certification bodies and consumers must be vigilant in verifying the authenticity of certifications when new products enter the market. A warning system for mislabeled products should be developed to enable consumers to identify issues that could unintentionally render a product non-Halal quickly. The widespread use of the internet can play a crucial role in combating such fraud and preventing the deliberate misuse of trademarks or breaches of agreements between food companies and certification bodies. Properly implemented laboratory testing protocols can monitor the compliance of products produced at manufacturing facilities between auditor visits, supporting the certification process. These practices motivate companies to avoid fraudulent activities. Companies offering Halal products should undergo systematic audits based on the complexity of their products and frequent changes in ingredients. Thus, some facilities, such as meat factories and restaurants, may require continuous monitoring, while others may be adequately audited on a daily basis or approximately every six months (Batu and Regenstein, 2014).

5. Food Traceability

Traceability refers to "the ability to distinguish, identify, and track the movement of a food or substance intended or expected to be included in a food through all stages of production, processing, and distribution" (FAO, 2017). Effective collaboration among stakeholders in the value chain is essential for sharing information on products and processes, ensuring the integrity of Halal products (Saifudin, Siti, and Ezanee, 2017). Thus, traceability systems serve as tools that help food manufacturers manage the flow of information and maintain product quality. Adequate traceability systems facilitate the recall of contaminated products, enhance customer experience, and ensure safety (ABT, 2022). In essence, food traceability is the ability to track an ingredient's journey from its source to its final destination. This involves identifying and tracking the farmers, processing facilities, storage, transportation, and distribution channels involved in getting food from the farm to a consumer's shopping cart (ABT, 2022).

In the food sector, which is based on the production of safe food, traceability is not only a standard but also a legal obligation. Traceability is a tool that allows the product to be

recalled if a food is deemed unsafe by the business or legal authorities. Thus, product traceability is crucial in food traceability. For this purpose, it is the process of determining the physical location of a product in the supply chain. Secondly, production processes are very important in terms of product traceability, and Process Traceability should be taken into consideration in this context (Ab-Rashid, Supian and Bojei, 2018). The scope and method of Food Traceability (Özbay-Doğu and Şireli, 2005) constitute the basic elements of the Halal traceability system within the integrated agriculture and food chain (Raspor, 2005).

1. Raw Material Traceability: It defines the physical location of a product at any point in the supply chain. It also determines the genetic structure and source of the product.

2. Product Processing Traceability: It determines the activities carried out during the cultivation and post-harvest processes and shows what, where, and when it was processed.

3. Input Traceability: It determines the type and source of the materials used. For example, fertilizers, additives such as colorants, stabilizers, preservatives, flavors, gelling agents, etc. used during the transformation into processed products.

4. Disease and Residue Traceability: It monitors the epidemiology of biological risks and residues, and includes microbiological hazards that may contaminate food products.

5. Measurement Traceability: It monitors the calibration and suitability of measurement and testing tools. It compares measurement results with standards for quality analyses during the production process. Halal Food Traceability monitors all substances used throughout the halal food production chain, the production process, personnel and the traceability of the final product (Raspor, 2005).

Awareness highlights how a person understands, perceives, and feels about a particular event or object. Halal awareness pertains to the understanding, perception, and feelings related to Halal values. To grasp Halal awareness, it's essential to explore how individuals comprehend and perceive the concept of Halal. This awareness is crucial not only for consumers but also for business actors. For consumers, Halal awareness means being conscious of purchasing and consuming Halal products (Hakiye, 2023).

In recent years, the concept of Halal awareness has become closely linked to food safety and quality on a global scale. In this context, the Halal orientation system is of vital importance, as it helps consumers reduce the risk of potential contamination with Haram substances in food (Handayani et al., 2019). Food safety and quality assurance are critical issues for stakeholders in the food industry. Halal food consumers are becoming increasingly conscious of the control of Halal processes throughout the supply chain (Yusaini et al., 2016). The concept of Halal also encompasses process control, packaging, storage, and delivery. To fulfill Halal objectives, it is necessary to protect the food integrity and safety of the product in addition to adhering to Islamic criteria. Integrity in halal food production is directly related to traceability in supply chain processes. A Halal traceability system is crucial for ensuring transparency in food processing and enabling customers to track food preparation processes (Poniman et al., 2015). Halal traceability encompasses the entire supply chain, including production and packaging activities, from the supply of raw food materials to the final product. Additionally, the Halal status of specific food products can be monitored at each stage of the supply chain (Prayudanti and Sucipto, 2021).

6. Halal Traceability in the Food Sector

More than two billion Muslims need halal food daily. The demand for halal food among customers is driving the expansion of the halal sector. Some countries require halal certification on food labels before allowing exports. The concept and feasibility of a halal traceability system are based on the purity and safety of halal food, adhering to Islamic laws, and considering environmental factors (Mirghani and Elnour, 2023). One of the challenges faced by Muslim consumers today is ensuring the "halalness" of a product, such as determining whether a product has been produced according to Islamic principles. This issue arises from the information asymmetry that can occur between buyers and sellers (Jannah and Al-Banna, 2021). Customer organizations must ensure that primary packaging (in terms of Halal traceability) complies with the Halal Food Standard. In Halal traceability applications, reference is made to the relevant Halal Food Standard to ensure and track the Halal compliance and traceability of products. Traceability of all processes, from supplier to customer or vice versa, must be proven. According to the SMIIC Halal food standard, non-Halal products cannot be produced in the same facility as Halal foods (SMIIC, 2012). If non-Halal certified products are present within the same facility, customer organizations must ensure the separation and non-contact of raw materials used in Halal-certified products, production lines, surfaces in contact with Halal-certified products, and storage areas of Halal-certified final products from other areas. The identification system for inputs, semi-finished products, partially used materials, final products, and products awaiting inspection must be specified within the traceability system, including primary packaging (Sigmacert, 2021). Integrating traceability systems and data transparency into a network context is crucial for enhancing food supply chains (Poniman et al., 2015). All parties involved, both upstream and downstream in the supply chain, must take individual and collective responsibility to protect Halal food products from intentional or unintentional cross-contamination (Zulfakar et al., 2014).

7. Halal Traceability Audit

Just as food safety audits are crucial for producing safe food, Halal traceability is equally important for ensuring the production of proper Halal food. Halal certification audits can be conducted according to the checklist of the relevant certification body. For instance, to produce Halal meat, the traceability of animals slaughtered for batch certification is ensured by the serial numbers specifically assigned to the animals by the country's relevant authority or ministry. During a Halal certification audit, the validity and authenticity of the Halal certificates for any raw materials or intermediates involved in the production process are verified. Additionally, it is preferable for the certification body issuing the Halal certificate to be recognized by SMIIC and member countries of SMIIC or accredited by HAK (the Turkey-based Halal Accreditation Agency) (Sigmacert, 2021).

During the audit, traceability of the products, including their Halal aspects, is carried out. Traceability reviews ensure that the requirements of a specific Halal Food Standard are met in all process stages from farm to fork. Any non-compliance (e.g., objections or complaints) is evaluated by the Halal Certification body. Traceability is essential for the use of Halal certificates and logos. Moreover, a certificate number must be present on the final product (Sigmacert, 2021).

Halal certification audits should verify whether the business produces Halal food products with a traceable structure and operates in a manner that respects all consumer rights concerning Halal compliance. The audits assess whether the business meets the requirements of the management system standard. Additionally, it should be checked whether the business uses products that comply with legal and Islamic principles, sourced from verifiable natural resources and analyzed by an accredited body, for all production and service processes (Meyem, 2022). Halal traceability can also be implemented using a QR code system. The QR code is a type of barcode system. With QR code scanning, information such as the certificate number of the customer organization, the product(s) evaluated for Halal compliance, the serial number of the relevant product, the batch number, the site(s) included in the certificate scope, the certificate status (active/suspended/canceled), the presence of doubtful substances according to OIC/SMIIC 24 (Food Additives and Other Chemicals) in the product content, and the compliance of the packaging/materials or materials in contact with food can be accessed (Sigmacert, 2021).

8. Halal Food Supply Chain

The literature on Halal food management indicates that the Halal supply chain has not received much attention (Haleem et al., 2020; Mohamed, Abdul Rahim, and Ma'aram, 2020). In addition, the supply chain (SC) in food and beverage production is becoming increasingly complex, and Muslim consumers are concerned about Halal food production in terms of the content and production methods of the foods they consume (Maifiah, Ahmad, and Iskandar, 2020). To identify potential issues with Halal compliance, a company needs to establish a robust tracking system that can uncover issues occurring throughout the supply chain. An effective traceability system in the Halal industry is crucial for developing and modeling the local Halal supply chain, and for the industry to gain a foothold in the global Halal food market (Shafii et al., 2012). The Halal supply chain generally comprises four distinct dimensions such as raw materials, production, service, and consumer (Ali et al., 2017). Halal traceability helps industry stakeholders identify and track vital information at each production stage, thereby eliminating instances of non-compliance (Vikaliana et al., 2021).

9. Blockchain Technique for Halal Food Supply Chain Traceability

Blockchain technology is an advanced database mechanism that enables transparent information sharing within a business network. In a blockchain, data is stored in blocks that are linked together in a chain and cannot be deleted or altered without consensus among the network stakeholders. Therefore, data can be stored chronologically and used as a ledger. The system prevents unauthorized transaction entries and is highly secure because it has built-in mechanisms that maintain consistency in the shared view of transactions (AWS, 2023). For each component in processed or packaged foods to be labeled and marketed as Halal, it must meet Halal standards. Modern food supply chains often involve dozens of stakeholders across multiple countries, making them more challenging to track and threatening the Halal status of many packaged foods (ABT, 2022). Halal integrity is fundamental to the Halal food sector. Despite the significant distances and various handling activities that Halal food products undergo within the supply chain, protective and preventive measures must be taken to ensure they remain Halal.

All parties must take individual and collective responsibility to protect Halal food products from intentional or unintentional cross-contamination. It is impossible for a single party to shoulder this substantial responsibility alone. Given the expected increase in demand for Halal food products in the near future, factors such as Halal certification, Halal standards, and Halal traceability must be considered. In this context, traceability is essential to monitor the entire supply chain. Halal food product traceability systems are necessary to ensure the transparency of food processing information and to enable customers to monitor and track the food preparation processes. Halal traceability, which encompasses all production activities from the origin of raw materials to final production, is gaining importance (Vikaliana et al., 2021). Large food supply chains can be complex, making traceability more challenging and threatening the Halal status of the final product. Blockchain technology can help reduce the risk of cross-contamination with non-Halal foods in the Halal industry by using accessible, real-time data to promote accountability (ABT, 2022).

Food traceability is the ability to track the journey of an ingredient from its source to its final destination. It involves identifying and tracking the farmers, processing facilities, storage, transportation, and distribution channels involved in moving food from the farm to an individual's shopping cart. Using blockchain technology for this purpose can be very effective. Having adequate traceability systems in place facilitates the recall of contaminated products, enhances customer experience, and protects their safety (ABT, 2022). In blockchain technology, hashing is the process of taking an input of any length and transforming it into an encrypted output through a series of mathematical algorithms. One purpose of this process is to conceal data. For example, passwords entered when registering on websites are hashed and stored in a database. This way, individuals examining the database cannot know or learn the user's password, creating a secure environment. Another purpose of hashing is to create a secure summary of the data. Regardless of the length of the input data, the output is always of the same length, allowing the hash code to be stored for summary purposes (IstanbulChain, 2021).

A new block is created, and once other participants agree on this state, the data is stored on this blockchain. This makes it very difficult to alter the chains and the data. Each new block in the chain contains a unique hash and the hash of the previous block. If someone tries to tamper with the data in a block, the hash will change and create an inconsistency with the next block, which still records the original hash. Therefore, the system will not allow this attempt (Deloitte, 2020).

Blockchain technology operates on a peer-to-peer network where every participant in the network holds a copy of the blockchain (Reiff, 2020). Consequently, all network partners have an updated copy of the blocks simultaneously, enabling them to view and track all historical data recorded in the blockchain. The key characteristics of Blockchain technology include security, an immutable recording system, and decentralization. As a result, the traceability of the Halal labeling process can be significantly enhanced. This technology allows each stakeholder to monitor the data from farm to table, ensuring transparency of information. Consequently, consumer confidence in the Halal labeling process is increased and strengthened. Implementing blockchain for Halal traceability offers advantages such as increased reliability and accountability in the Halal labeling process (Deloitte, 2020).

Blockchain technology makes data extremely secure by storing it in numerous hashes in a decentralized system. The Malaysian supply chain company Fluree and the supply management platform Sinisana have recently designed an innovative online ledger system called Intersect to track Halal food production using real-time data. Intersect aims to build trust and transparency between Halal food producers and consumers by making supply chain data more accessible (ABT, 2022). Blockchain is anticipated to offer several benefits, including transparency, real-time information about products, fraud prevention, resistance to manipulation, reduced operational costs, auditability, improved product quality, safe and healthy consumption, and a more structured Halal certification process (Tan et al., 2020). A Halal food product is typically certified by a Halal authority in the country of origin when the relevant data is entered into a blockchain block. This data is updated as the food item moves through the supply chain, whether it is moving to a storage location, a warehouse, or an intermediary party (Ali et al., 2021).

Traditional supply chains face challenges at every point. For example, fraudulent actions such as delayed delivery, theft, and spoilage, misuse, contamination, and issues that cannot be easily detected using visual inspections can arise. Concerning Halal food supply chains, issues like cross-contamination, Halal fraud, logistical problems, and the lack of a universally accepted Halal standard have always been at the forefront of public discussion (Ali and Süleyman, 2016). Since not everyone has access to information, maintaining control over the entire system is challenging, and the Halal sector faces issues of inaccuracies and lack of authenticity, which significantly reduce the integrity of the food supply chain (Abidin and Perdana, 2020).

To ensure the highest security and quality standards of the Halal food supply chain, AI-powered solutions can be integrated into the existing food safety framework. When AI is applied to Halal food safety, it offers numerous benefits, such as increased accuracy and efficiency, improved transparency, and real-time monitoring of food traceability and verification processes. Consequently, AI-powered solutions enable Halal food to meet the growing needs and expectations of consumers while adhering to the highest safety and quality standards. Continuous innovations in this field will be crucial to ensuring that Halal food remains safe, reliable, and of the highest quality (Ahmed, 2023a). While data is important for AI, having this data in a centralized storage area brings scalability and security constraints. Blockchain, with its decentralized nature, provides an important storage infrastructure for AI. With blockchain, the required data can be pulled and used from a scalable database as needed (Salah et al., 2019).

10. Artificial Intelligence and the Halal Food Sector

AI can help in preventing contamination and streamlining the certification process. AI-powered solutions can meet the growing needs and expectations of Halal food consumers while achieving the highest safety and quality standards. Therefore, implementing AI solutions for Halal food safety is a worthwhile task. AI-based solutions such as content and product analysis, food tracking systems, traceability and labeling solutions, and Halal certification and auditing can significantly enhance Halal food traceability and therefore, safety (Ahmed, 2023b).

As AI advances, the Halal sector can benefit from further innovations. From personalized recommendations for Halal products to advanced supply chain management, AI has

the potential to revolutionize the operations of the Halal sector. By adopting AI, businesses can meet the growing demands of Halal consumers and steer the sector towards further growth and development (Seabiscuit, 2024). AI can also help address the gap in standardization within the Halal food market. Since Halal standards differ between countries, businesses often face confusion and compliance issues. AI systems can be programmed to understand and adapt to these varying standards, assisting companies in navigating compliance complexities and ensuring their products meet the required criteria across different markets. Initiatives such as funding and training opportunities will be crucial to support these businesses and foster inclusive growth in the AI-powered Halal market. Despite the challenges, the potential benefits of AI for the Halal market are substantial. AI can promote growth in the Halal sector by enhancing efficiency, compliance, and personalization (Ahmed, 2023a).

11. Artificial Intelligence in Food Safety Control

Halal food safety is crucial for several reasons. Firstly, Halal food is an integral part of the Muslim community, and ensuring its safety is a top priority for those who follow Islamic dietary rules. Secondly, with the growing global demand for Halal food, maintaining quality and safety is essential to meet the needs of an increasing number of consumers. Thirdly, the complexity of the Halal food supply chain presents challenges in maintaining safety and quality, making it important to explore innovative solutions to address these issues. AI can be leveraged to enhance these efforts. Lastly, ensuring Halal food safety is vital for consumer health and well-being, as it helps prevent contamination and reduces the risk of foodborne illnesses. In summary, Halal food safety is essential for preserving the quality and integrity of Halal food and ensuring its safe consumption for everyone (Ahmed, 2023b). Ensuring Halal food safety is achievable with the use of AI.

Blockchain can facilitate more transparent AI operations. Indeed, blockchain can store all information about how AI makes decisions in blocks. This information is immutable and always accessible. Thus, all information regarding how AI makes decisions becomes available. If AI makes an incorrect decision, identifying the error becomes quickly possible. In this regard, improvements can be made both in the data used and the algorithms. This traceability and transparency increase users' trust in AI systems (Saigal, 2020).

Image processing-based inspection and production methods are increasingly utilized in various sectors of the food industry (Patel et al., 2012; McAllister et al., 2018). Research indicates that image processing technology can effectively inspect and classify fruits and vegetables assess the quality of grains, baked goods, pizza, cheese, pasta, and other food products. This technology supports the development of fully automated systems capable of meeting rising production and quality demands with high speed and precision (Patel et al., 2012).

Currently, quality assessment in the food industry largely relies on manual inspection, which is labor-intensive, costly, and prone to subjective and inconsistent results due to physiological factors (Du and Sun, 2006). In quality management systems like ISO22000 and HACCP, and in internal or hygiene control practices within companies, hygiene assessments are often conducted subjectively by individuals. Consequently, control results are recorded in a straightforward but non-incentivized manner, often just marked with a

check or plus sign. Emerging computer vision and AI technologies have the potential to enhance this area by providing more objective, accurate, and efficient quality assessments (Özdemir, Cam, and Kayahan, 2021).

As awareness and expectations regarding food quality and safety continue to rise, new technological systems are needed to enhance quality control in the food industry. Artificial intelligence research explores methods to conduct hygiene, cleanliness, and order control in production areas using visual indicators. These advancements promise fast, continuous, and objective control, addressing the needs of the food industry as highlighted in the literature (Sun and Brosnan, 2003; Brosnan and Sun, 2004).

For the growing number of Muslims worldwide who adhere to Islamic (Halal) dietary laws, Halal food safety is critically important. Ensuring the safety and quality of Halal food involves managing a complex supply chain, from raw material sourcing to final production and distribution. This task can be challenging, but AI has the potential to simplify it significantly. Additionally, the issue of counterfeit Halal products is becoming more prominent. When combined with technologies like blockchain, AI can enhance product authentication, thereby increasing consumer trust and confidence in Halal products (Ahmed, 2023a).

12. Integration of Blockchain and Artificial Intelligence

Blockchain and artificial intelligence (AI) are two rapidly evolving, highly popular technologies that address various sectors. Although these technologies serve very different functions, they can be used together. Combining these two technologies can leverage the benefits of both while mitigating their disadvantages (Saigal, 2020). Therefore, it is essential first to consider the advantages and disadvantages of each technology. Blockchain, for instance, offers numerous advantages, primarily due to its decentralized nature. Its capabilities for transparency, security, and controllability are among its most significant benefits. However, it also has some disadvantages. For example, every node in the blockchain network must validate a transaction before it can be executed (İmamoğlu, Erat, and İnce, 2023).

Blockchain significantly supports AI by facilitating the emergence of more robust and advanced AI applications. It contributes valuable data and algorithms needed for AI, helping AI to be more transparent and reliable in problem-solving (Dinh and Thai, 2018). Data is crucial for AI, and blockchain is seen as a significant support for AI in data acquisition, storage, and sharing (Karger, 2020). One of the reasons is that blockchain provides transparency to users. Therefore, it is possible to access information about who accessed the data and when. This encourages users to feel more comfortable, trustful, and inclined to share data (Dinh and Thai, 2018). While transparency and immutability are advantageous, they can potentially compromise user privacy in adverse situations. Although generally considered secure, serious problems can arise if smart contracts are attacked (Gatteschi et al., 2018; Sarmah, 2018). Similarly, AI offers various advantages, such as being faster than humans, completing complex tasks easily and quickly, handling multiple tasks simultaneously, having a low error and high success rate, being more efficient, and discovering new situations. However, AI also has disadvantages (Khanzode and Sarode, 2020). This integration generally provides collective decision-

making, advanced data security, high efficiency, and decentralized intelligence. Integrating these technologies can benefit various areas, such as automating customer services in marketing, removing spatial constraints and optimizing e-payment and decision-making over the network in e-commerce, improving the flow of products, information, and financial resources in the supply chain, and identifying risky customers in finance and accounting (Kumar et al., 2023).

13. Conclusion

There is a need for a suitable guideline to ensure Halal compliance throughout the production, transportation, and distribution systems for Halal food producers. It is important to focus on food supply chains since the theoretical repeatability of the framework for other Halal food producers is of interest. Data stored across different servers helps prevent data manipulation, as any attempts to alter the data are immediately flagged to other parties in the network. For example, if a veterinarian tries to change the health status of an unhealthy chicken from sick to healthy in a poultry slaughterhouse database, this action will be visible to everyone in the network. This transparency enhances consumer trust in the integrity of Halal products (Deloitte, 2020).

Halal traceability applications can significantly enhance food safety, quality, and consumer confidence. In this context, traceability systems hold strategic importance in the Halal sector. An effective traceability system is essential for the Halal industry's success in the global market. This system is crucial for developing and modeling local Halal supply chains, ensuring the industry's sustainability and growth. The main points of Halal traceability and monitoring include acceptable risk levels and participation in the Halal traceability and monitoring system (Vikaliana et al., 2021).

Recently, the image of the Halal food industry could be significantly improved through serious Halal certification and established traceability. However, fraud in Halal certification can still be a serious issue. Additionally, physical contamination of Halal food products could compromise Halal food production safety. Halal traceability is one of the fundamental requirements of holding a Halal certification, necessitating a secure traceability system for Halal food production. Businesses wishing to hold a Halal certificate must have an effective traceability process for each stage of production until it reaches the end consumer and must implement this process effectively. In this context, traceability is one of the fundamental requirements verified in Halal certification audits (Meyem, 2022).

In recent years, the Halal supply chain has become crucial to ensuring the safety of food and beverage products. Despite certification for Halal supply chain practices, fraud cases can still be a global issue. Muslim consumers are increasingly demanding transparent traceability. In this context, Blockchain technology, known for its security and transparency, can offer a robust solution.

The intersection of AI and the Halal sector presents numerous opportunities for businesses to grow and meet consumer expectations. The Halal sector can streamline certification processes, ensure compliance and quality control, and gain valuable insights into market trends through AI-supported processes. As AI continues to advance, the Halal industry needs to adopt this technology and leverage its innovation and growth potential (Seabiscuit, 2024).

14. References

Abidin, N. Z., and Perdana, F. F. (2020). A Proposed Conceptual Framework for Blockchain Technology in Halal Food Product Verification. J. Halal Industry Services. 3, 2637–0891. doi:10.36877/jhis.a0000079

ABT, (2022). Advanced Biotech. Improving Traceability and Transparency in Halal Supply Chains. Nov 17, 2022 https://adv-bio.com/improving-traceability-and-transparency-in-halal-supply-chains/

Ab-Rashid, N., Supian, K. and Bojei, J. (2018). Relationship between Halal Traceability System Adoptions on Halal Food Supply Chain Integrity and Performance. International Journal of Asian Social Science, 8(1), 569-579.

Ahmed, H. M. (2023a). Could Artificial Intelligence Be A Game-Changer in Halal Marketing?. The Halal Times. https://www.halaltimes.com/could-artificial-intelligence-be-a-game-changer-in-halal-marketing/

Ahmed, H. M. (2023b). How To Improve Halal Food Safety by Using AI ?. The Halal Times. https://www.halaltimes.com/how-to-improve-halal-food-safety-by-using-ai/

Akgündüz, A. (2012). Helal Gıda Meselesi: Avrupa'da Helal Gıda Problemleri ve Çözüm Yolları. İhracat İçin Helal Sertifikası Sempozyumu Bildirileri. S:1-14. 14 Şubat 2012. Güney Marmara Kalkınma ajansı. Balıkesir.

Ali, M. H., and Suleiman, N. (2016). Sustainable Food Production: Insights of Malaysian Halal Small and Medium Sized Enterprises. Int. J. Prod. Econ. 181, 303–314. [online] Available.at:https://www.sciencedirect.com/science/article/abs/pii/S0925527316301086. doi:10.1016/j.ijpe.2016.06.003

Ali, A., Xiaoling, G., Sherwani, M., & Ali, A. (2017). Factors affecting Halal meatpurchase intention. British Food Journal.

Atman, Ü. C. (2004). Gıda Katkı Maddeleri ve Gıda Kontrolü. STED, 13(3):86-88. http://www.ttb.org.tr/STED/sted0304/gida.pdf

AWS, (2023). Blok zinciri teknolojisi nedir. https://aws.amazon.com/tr/what-is/blockchain

Batu, A. (2012a). Helal (Mahzursuz) Gıda Belgelendirmesindeki Sorunlar ve Çözüm Önerileri. Gıda Teknolojileri Elektronik Dergisi, 7 (2), 60-75.

Batu, A. (2012b). Türkiye'de Helal (Mahzursuz) Gıda ve Helal Belgelendirme Sistemi. Gıda Teknolojileri Elektronik Dergisi, 7(1), 51-61.

Batu, A. and Regenstein, J. M. (2014). Halal Food Certification Challenges and Their Implications for Muslim Societies Worldwide. Turkish Studies - International Periodical For The Languages, Literature and History of Turkish or Turkic, 9 (11), 111-130.

Brosnan T and Sun DW. (2004). "Improving quality inspection offood products by computer Vision: a review". Journal of Food Engineering 61 (2004): 3-16.

Çakır, S. (2013). Yediklerimiz Helal Olsun. Işık Yayınları, Çağlayan Matbaası. Gaziemir-İzmir. 259 sayfa. Helal Gıda Sertifikası, sayfa 183. ISBN: 978-975-278-905-0

Çelen, M. (2010a). Fıkıhsız Helal Gıda Olmaz. Helal ve Sağlıklı Gıda ve Doğal Beslenme. http://www.helalvedogal.com/fikihsiz-helal-gida-olmaz/

Çelen, M. (2010b). Dünya'da Helal Sertifikalama. HEDEM Helal Gıda Denetim ve Sertifikalandırma Merkezi. http://www.helaldenetim.com/makale.aspx?makaleid=83.

Deloitte, (2020). Using Blockhain to Drive Supply Chain Transparency. Available at:https://www2.deloitte.com/us/en/pages/operations/articles/blockchainsupply-chain-innovation.html (Retrieved June 26, 2020).

Dinh, T. N., Thai, M. T. (2018). AI and blockchain: A disruptive integration. Computer, 51(9), 48-53.

Du C J and Sun D W. (2006). "Learning techniques used in computer vision for food quality evaluation: a review". Journal of Food Engineering 72 (2006): 39-55.

FAO, (2017). Food Traceability Guidance. Santiago: Food and Agriculture Organization of the United Nations.

Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C., Santamaria, V. (2018). To blockchain or not to blockchain: That is the question. IT Professional, 20(2), 62-74.

Hakiye, A. (2023). The influence of halal awareness, halal certificate, subjective norms, perceived behavioral control, attitude and trust on purchase intention of culinary products among Muslim costumers in Turkey. International Journal of Gastronomy and Food Science. 32(1):100726

Haleem, A., Khan, M. I., Khan, S., & Jami, A. R. (2020). Research status in Halal: a review and bibliometric analysis. Modern Supply Chain Research and Applications.

Handayani, D. I., Hafiz, M., Mohamed, M., Ab, M. S., Haleem, A., Khan, M. I., Khan, S., Jami, A. R., Utara, U. S., Nur, T., Purwanto, S., Windarwati, S., Poniman, D., Purchase, S., & Sneddon, J. (2019). Traceability in Halal Food Supply Chains from a Business Network Perspective. Procedia-Social and Behavioral Sciences, 2(01), 33–41.

İmamoğlu, S. Z., Erat, S. ve İnce, H. (2023). Blokzincir ve Yapay Zeka (pp.237-256). In book: Yönetim Biliminde Yapay Zeka. 306 Sayfa. Yayınevi. Nobel Bilimsel Eserler. ISBN978-625-393-012-7

İstanbulChain, (2021). Hash Nedir?. *https://medium.com/@iublocktech/hash-nedir-398faa583940*

Jannah, S.M. and Al-Banna, H. (2021). Halal Awarness and Halal Traceability: Muslim Consumers' and Entrepreneurs' Perspectives. Journal of Islamic Monetary Economics and Finance, 7(2), 285–316.

Karger, E. (2020). Combining blockchain and artificial intelligence – Literature review and state of the art. In Forty-First International Conference on Information Systems, (pp. 1-17). India.

Khanzode, K. C. A., Sarode, R. D. (2020). Advantages and disadvantages of artificial intelligence and machine learning: A literature review. International Journal of Library & Information Science, 9(1), 30-36.

Kumar, S., Lim, W. M., Sivarajah, U., Kaur, J. (2023). Artificial intelligence and blockchain integration in business: trends from a bibliometric-content analysis. Information Systems Frontiers, 25(2), 871-896.

McAllister, P., et al. (2018). Combining deep residual neural network features with supervised machine learning algorithms to classify diverse food image datasets. Computers in Biology and Medicine 95 (2018): 217-233.

Meyem, (2022). Helal Belgelendirme. Meyem - Mesleki Yeterlilik ve BelgelendirmeMerkezi. https://meyem.com.tr/hizmetler-helal-belgelendirme.html

Maifiah, M. H. M., Ahmad, A. N., & Iskandar, M. A. (2020). A conceptual framework highlighting barriers in cold chain management for Halal food products in South-East Asian countries. In Halal Logistics and Supply Chain Management in Southeast Asia (pp. 51-66). Routledge.

Mohamed, Y. H., Abdul Rahim, A. R., & Ma'aram, A. (2020). The effect of halal supply chain management on halal integrity assurance for the food industry in Malaysia. Journal of Islamic Marketing.

Mirghani, M.E.S., Elnour, A.A.M. (2023). Concept and Significance of the Halal Traceability System. In: Ahmed Osman, O., Moneim Elhadi Sulieman, A. (eds) Halal and Kosher Food. Springer, Cham. https://doi.org/10.1007/978-3-031-41459-6_4.

Muhamad, N., Leong, V. S., & Isa, N. M. (2017). Does the country of origin of a halal logo matter? The case of packaged food purchases. Review of International Business and Strategy, 27(4), 484–500.

Mohamed, Y. H., Rahman, A., Rahim, A., Binti, A., & Ghazli, M. (2016). *Halal Traceability in Enhancing Halal Integrity for Food Industry in Malaysia – Halal Traceability in Enhancing Halal Integrity for Food Industry in Malaysia – A Review*. *March*.

Özdemir, Y., Cam, Ö. N. and Kayahan, S. (2021). Artificial Intelligence in Food Safety Control. Acta Scientific Computer Sciences, 3(7), 23-28.

Özbay-Doğu, S. ve Şireli, U. T. (2005). Gıdalarda İzlenebilirlik. Gıda, 40 (5): 295-302

Patel K K., et al. (2012). "Machine vision system: a tool for quality inspection of food and agricultural products". Journal of Food Science and Technology 49 (2012): 123-141.

Prayudanti, A. A. and Sucipto, S. (2021). Halal and safety traceability of material, production, and serving of local food in Surabaya: A review. 2021 International Conference on Green Agroindustry and Bioeconomy. IOP Conf. Series: Earth and Environmental Science 924 (2021) 012002. IOP Publishing.

Poniman, D., Purchase, S., & Sneddon, J. (2015). Traceability systems in the Western Australia halal food supply chain. Asia Pacific Journal of Marketing and Logistics, 27(2), 324–348.

Raspor, P. (2005). Bio-Markers: Traceability in Food Safety Issues. Acta Biochim Pol,

52 (3): 659-664.

Reiff, N. (2020). Blockchain Explained. Available at: https://www.investopedia.com/terms/b/blockchain.asp#:~:textEach%20computer%20in%20the%20blockchain,cpies%20of%20the%20same%20blockchain (Retrieved June 02, 2020).

Riaz, M. N. and Chaudry, M.M. (2004). Halal Food Production. CRC Press LLC, 2000 N.W.Corporate Blvd., Boca Raton, Florida 33431. USA.

Saigal, P. (2020). Merger of artificial intelligence and blockchain. P. Raj, K. Saini ve C. Surianarayanan (Eds.), Blockchain technology and applications içinde (pp. 139-158). New York: CRC Press.

Sakr, A.H. (1988). A Handbook of Muslim Foods. Publish by Foundation for Islamic Knowledge, Lombard IL. USA.

Salah, K., Rehman, M. H., Nizamuddin, N., and Al-Fuqaha, A. (2019). Blockchain for AI: Review and Open Research Challenges, IEEE Access, 7 (1), 10127-10149.

Sarmah, S. S. (2018). Understanding blockchain technology. Computer Science and Engineering, 8(2), 23-29.

Seabiscuit, (2024). Yapay zekanın Helal sektöründe nasıl devrim yarattığını keşfedin.

https://www.seabiscuit.ai/ai-in-idustry/a/ai-in-the-halal-industry/r/rec3ej4lVc7tz1fCZ

Saifudin, A. M., Siti, O., and Ezanee, E. (2017). Exploring in Setting a Model for Islamic Supply Chain in Malaysia. Int. Rev. Management Marketing 7 (1), 95–102.

Sun, D.W. and Brosnan, T. (2003). Pizza quality evaluation usingcomputer vision—Part 1 Pizza base and sauce spread. Journal of Food Engineering 57 (2003): 81-89.

Sigmacert, (2021). Sigmacert Uluslararası Belgelendirme Eğitim ve Test Hizmetleri LTD. ŞTİ. H.T.05 Helal Uygunluk Değerlendirme Faaliyetleri ve İzlenebilirlik Klavuzu. https://www.sigmacert.com/wp-content/uploads/2021/08/H.T.05-Helal-Uygunluk-Degerlendirme-Faaliyetleri-ve-Izlenebilirlik-Kilavuzu-REV03-23.01.2021-7.pdf

Shafii, Z., Khadijah, W. M. N. W. S., Nilai, B. B., & Sembilan, N. (2012). *Halal Traceability Framework for Halal Food Production Faculty of Economics and Muamalat , Universiti Sains Islam Malaysia ,. 17*, 1–5.

SMIIC, (2012). The Standards and Metrology Institute for Islamic Countries, available at: https://www.smiic.org/en

Samsi, S. Z. M., Tasnim, R., & Ibrahim, O. (2011). Stakeholders' Role for an Efficient Traceability System in Halal Industry Supply Chain. https://doi.org/10.5176/978-981-08-8227-3_erp-scm16

Tan, A., Gligor, D., & Ngah, A. (2020). Applying Blockchain for Halal food traceability. International Journal of Logistics Research and Applications, 25(6), 947–964.

Vikaliana, R., Evitha, Y., Harimurti3, C., Sabaruddin, L. and Komala, A. L. (2021). A Literature Highlight: How A Traceability System Can

Support Halal Supply Chain? *Budapest International Research and Critics Institute-Journal,, 4,(4), 7620-7628.*

Yusaini, H., M., Abd Rahman, A. R., Azanizawati, M., & Mohd Ghazli, H. (2016). Halal Traceability in Enhancing Halal Integrity for Food Industry in Malaysia – A Review.*International Research Journal of Engineering and Technology*, *3*(3), 68–74.

Zulfakar, M. H., Anuar, M. M., & Talib, M. S. A. (2014). Conceptual Framework on Halal Food Supply Chain Integrity Enhancement. *Procedia - Social and Behavioral Sciences*, *121*, 58–67.

Tezcan, M. (1997). "Yemek Kültürü Üzerine Dinsel Etkiler", Türk Mutfak Kültürü Üzerine Arastırmalar: Türk Halk Kültürünü Arastırma ve Tanıtma Vakfı Yayın No:20, 1997/139-146, Ankara.

Topbaş, O. N. (2014). Genç Dergisi. Yıl: 2014 Ay: Nisan Sayı: 91

Türkoğlu, İ. and Pekcan, G. (2013). Menstrual Döngü Sürecinde Dinlenme Metabolik Hızı, Vücut Bileşimi ve Besin Alımındaki Bireysel Farklılıkların Saptanması. Beslenme ve Diyet Dergisi, 41(3), 212-220.

Williams, D. (1995). Breast-Feeding Best Bet For Food and Drug Administration (İnternet). 1995 Şubat; http://www.bpni.org/Article/Breast-Feeding_Best_Bet_for_Babies.pdf

Yalızuçanlar, S. (2013). "Sohbet Canı Semirtir, Ruhun Gıdalandığı Sohbeti" Elmalıda Kişilik Oluşumu ve Nefsin Terbiyesi Sempozyumu Bildiriler Kitabı, Akdeniz Kültür ve İletişim Kulubü, Antalya, 2013, s.51.

Yeşilay, (2024). Sigara ve alkol anne sütünü zehirliyor.https://www.yesilay.org.tr/tr/haberler/sigara-ve-alkol-anne-sutunu-zehirliyor