



Combining science and faith for better quality and safety in halalan toyyiban products

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ABSTRACT

Halalan Toyyiban, a concept rooted in Islamic teachings, is focused on quality, safety, ethical considerations, and permissibility. "halal" is defined as items permissible under Islamic law, while "toyyib" ensures the items are pure, wholesome, and ethically sourced. This concept, derived from the Quran and Sunnah of the Prophet Muhammad (PBUH), provides a comprehensive framework for guiding Muslim practices. In global marketplace, integrating scientific methods with halalan toyyiban principles is becoming increasingly important, particularly in the food, cosmetics, and pharmaceutical industries. Scientific methods offer effective tools for verifying the halal status of products and enhancing the toyyib attributes. This integration helps ensure that products meet both Islamic and modern standards, thereby strengthening the credibility of halal certifications through evidence-based practices. Techniques, such as chromatography, DNA testing, and mass spectrometry, were commonly adopted to detect non-halal contaminants and verify product integrity. These innovations reassures consumers that the products are religiously permissible and meet high standards of safety and ethical production.

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1 Introduction

Halalan Toyyiban is specifically designed for Muslims through the revelation of the Quran and the practice of the Sunnah of the Prophet Muhammad PBUH. Halal, derived from Arabic, refers to actions, objects, or behaviours that are permissible or lawful, while haram denotes unlawful or prohibited actions (Al-Mahmood & Fraser 2023). Based on the Islamic faith, halal is a fundamental element of Muslim practice that advocates strict adherence to permissible and lawful rules in various aspects of life. It pertains to what is acceptable under Islamic law, and "toyyib" goes beyond that to guarantee that the permissible items are of the highest quality, devoid of any damage, and produced ethically and sustainably. Integrating science and Halalan Toyyiban with innovative approaches is essential for industries. The focus was on creating products and services that are in line with the latest scientific advancements and adhere to Islamic values. This integration foster a higher level of assurance to consumers that the products used are permissible under Islamic law and meet the highest standards of safety, quality, and wholesomeness. Therefore, this study aimed to explore the integration of science and the Halalan Toyyiban. It examine the correlation between scientific advancements and Toyyiban's principles to ensure products and processes meet the highest standards of safety, quality, and ethical compliance, thereby benefiting both businesses and consumers. The narrative review collected key articles from various sources to provide an overview of important results and perspectives on the topic discussed.

2 Methodology

The methodology employed in this study follows a narrative review approach, synthesizing key findings from various scholarly sources to provide a comprehensive overview of the integration of halalan toyyiban principles with scientific advancements. The authors conducted an

extensive literature analysis, focusing on previous studies and secondary data to explore the application of advanced scientific methods—such as chromatography, polymerase chain reaction (PCR), and mass spectrometry—in ensuring product compliance with halalan toyyiban standards. Real-world examples, including the use of DNA-based technologies for detecting non-halal contaminants and the development of halal-compliant gelatin from fish bones using ultrasound-assisted extraction, were discussed to illustrate the practical application of these principles across sectors such as food, pharmaceuticals, and cosmetics. A multidisciplinary approach was emphasized, integrating knowledge from fields like biotechnology, food science, pharmacology, and Islamic jurisprudence (fiqh) to develop innovative solutions for halal product assurance. The study also addressed future prospects, highlighting emerging technologies such as blockchain for enhancing transparency in halal supply chains and electronic noses (e-noses) for reliable halal authentication. This methodology underscores the convergence of religious principles and scientific innovation to ensure products meet high standards of safety, quality, and ethical compliance.

3 Foundations of Halal and Toyyib Concept

The concept of the Halalan Toyyiban is derived from Islamic teachings and emphasized in the Quran through several verses:

"O mankind, eat from whatever is on earth [that is] lawful and good (halalan toyyiban) and do not follow the footsteps of Satan. Indeed, he is to you a clear enemy." Surah Al-Baqarah (2:168)

"And eat of what Allah has provided for you [which is] lawful and good (halalan toyyiban). And fear Allah, in whom you are believers." Surah Al-Ma'idah (5:88)

"So eat of what Allah has provided for you [which is] lawful and good (halalan toyyiban). And be grateful for the favor of Allah, if it is [indeed] Him that you worship." Surah An-Nahl (16:114)

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The term "halal" denotes permissibility under Syariah principles, while "toyyib" signifies wholesomeness and good quality (Alzeer *et al.* 2018). For example, chickens slaughtered according to Islamic guidelines, such as mentioning the name of Allah, proper slaughtering methods, and drained blood, are considered to be halal. However, when raised in a healthy environment, free from harmful chemicals, antibiotics, and hormones, and fed nutritious feed, it is also considered a toyyib. Chickens that are halal but raised under poor conditions or exposed to harmful substances may not be toyyib. From a business perspective, a company that adheres to Islamic law by engaging in lawful trade and avoiding prohibited activities, such as gambling, interest (riba), and fraud, is considered halal. A business, attains the status of toyyib by exceeding halal standards to ensure fair wages, ethical treatment of workers, sustainable practices, and corporate social responsibility. Consequently, a business that is technically halal but exploits workers or damages the environment, falls short of being considered toyyib. Despite having different meanings, halal and toyyib represent complementary concepts in Islamic teaching, particularly concerning food, products, and practices. This integrated concept creates a comprehensive system that combines religious obligations with practical benefits, addressing all aspects, such as hygiene, safety, quality, and ethics, as shown in Figure 1. The verification of halal status is essential before determining toyyib (Abdul Mokti *et al.* 2024).

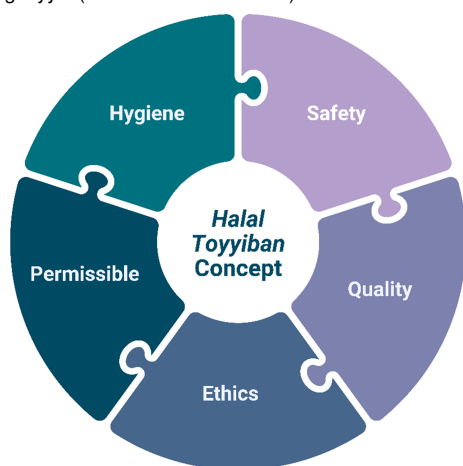


Figure 1: Halalan toyyiban concept

4 Integration of Halal and Toyyib with Scientific Approach

The integration of halal and toyyib using a scientific approach represents a significant advancement in ensuring that products and practices adhere to both Islamic principles and high standards of hygiene, quality, safety, and ethics. This is becoming increasingly essential in the global halal industry, which includes various industries, such as food, cosmetics, pharmaceuticals, and other consumer goods. Through scientific approaches, accurate halal verification and the enhancement of Toyyib standards can be achieved. In addition, the certification can be strengthened through evidence-based practices.

A key aspect of this integration is the use of "halal detection technologies" (HDTs), that adopts scientific methods to address the issue of contamination from non-halal sources (Sani *et al.* 2023). HDTs, as essential tools, help detect non-halal contaminants, such as pork, derivatives from dogs, unslaughtered animals, and alcoholic beverages, which are considered harmful to Islam. Furthermore, these technologies can be used to identify potentially harmful substances, such as toxic or poisonous chemicals, detrimental to consumer health. For example, chromatography, DNA testing, and mass spectrometry provide concrete evidence that a product is free from prohibited or harmful substances, ensuring halal and toyyib standards are met.

Chromatography-based methods, such as liquid and gas chromatography using various detectors, have been widely applied to authenticate various products, including halal analysis, due to the numerous advantages (Nurani *et al.* 2022). As discussed by Lehotay & Hajšlová (2002), Gas Chromatography (GC) is particularly well-suited for detecting smaller volatile compounds that are stable under heat, making it ideal for analyzing substances such as alcohols, flavors, and fragrances present as contaminants. In contrast, Liquid Chromatography (LC) is more robust and is preferred for the analysis of larger, less volatile, or non-volatile compounds such as proteins, fats, and other complex molecules. Both GC and LC methods are essential for halal detection analysis because they complement each other in terms of the types of compounds to be analyzed. For example, a study by Von Barga *et al.* (2013) showed that the combination of HPLC and tandem mass spectrometry is an alternative to PCR and enzyme-linked immunosorbent assay (ELISA) methods for the sensitive and rapid detection of different meat contaminants in food. In a different study, liquid chromatography-high-resolution mass spectrometry (LC-HRMS) using an untargeted approach combined with chemometrics

was successfully applied to analyze non-halal raw beef meat (Windarsih *et al.* 2024).

DNA-based methods, particularly polymerase chain reaction (PCR), are effective approaches for addressing halal and toyyib concerns. PCR is an in vitro method that enables the exponential amplification of specific DNA templates using cycles of temperature changes. DNA template, DNA polymerase enzyme, reaction buffer, and primers (forward and reverse) were the reagents used to specify the exact product to be amplified (gene) (Rohman *et al.* 2020). PCR-based techniques are conceptually simple, sensitive, highly specific, and amenable to complete automation using computer software. However, this method is not without limitations as DNA polymerases are prone to errors and can produce mutations, and nonspecific primer binding may affect the specificity Prachugsorn *et al.* (2022) successfully produced a direct asymmetric PCR and catalyzed hairpin assembly fluorescent biosensor assay (daPCR-CHA-FB) to detect porcine DNA in raw and processed food. This novel sensor was combined with an in-house portable LED light-box. The validation of the assay showed that the method was reproducible, specific, sensitive, and accurate. Furthermore, a study has established a DNA-based porcine detection system in line with the mitochondrial cyt-b gene, which is viable for detecting pork in highly processed products. The primer pairs used include 1F1R (forward: 5'-ATGCCCGTTTCTTGTAACCG-3'; reverse: 5'-GAGGAGGAGGAGGAGGAG-3'), 2F2R (forward: 5'-ATGACCTGACCCACCAAG-3'; reverse: 5'-TACCCACCAAGTGCAAA-3'), and 3F3R (forward: 5'-GGTCTAGGAACGAGGAG-3'; reverse: 5'-CCAGCCAGGAGGAGGAGG-3'). This method has been recommended for use in the halal certification process to identify pork adulteration in foods (Akteer *et al.* 2021).

Blending halal and toyyib principles with scientific techniques represents a major step forward in ensuring that products not only adhere to Islamic guidelines but also meet top-notch quality and safety standards. Using advanced tools such as GC, LC, and PCR, halal status can be precisely verified, with products being ensured to be free from non-halal contaminants and harmful substances.

5 Real-life Integration of Halalan Toyyiban and Scientific Approach in Various Products

As industries evolve, integrating halalan toyyiban with scientific methods has become crucial, particularly in the food, pharmaceutical, and cosmetics sectors. This integration not only ensures adherence to religious requirements but also guarantees safety and effectiveness in product offerings.

In the food industry, halal certification is a key requirement for companies aimed at serving the global Muslim population. This shows the commitment to complying with Islamic law, ensuring the permissibility of products for Muslim consumers. In addition to meeting religious standards, scientific rigour is important to guarantee that products are toyyib. To preserve the authenticity of halal food, a range of advanced analytical methods has been adopted to detect prohibited substances and verify the absence of unlawful substitutions. Conventional methods such as physicochemical techniques and electrophoresis have long been utilized in halal food analysis (Ng *et al.* 2022). Chromatography and immunoassays are frequently used to detect the presence of animal products in food. With rapid developments in molecular biology, DNA-based techniques are becoming more common in food authentication. Various DNA-based methods such as PCR, biosensors, and clustered regularly interspaced short palindromic repeat (CRISPR) technologies have been developed to enhance the detection of pork in food. The stability of DNA even after heat processing, makes it a reliable tool for accurate species identification (Muflihah *et al.* 2023).

A significant challenge within the halalan toyyiban framework is the widespread use of gelatin in the confectionery industry. Traditionally derived from pork skin, bones, and cattle hides (Alipal *et al.* 2019), gelatin requires halal-compliant alternatives. Fish bones, particularly from species such as Pangasius (Patin fish), offer a promising source, constituting 10-20% of fish weight (Asih *et al.* 2019). A study by Asih *et al.* (2019) focused on extraction from fish bone by-products using ultrasound-assisted extraction. The result showed that a 5-hour extraction time provided the highest yield, achieving $5 \pm 1.03\%$ gelatin with desirable gel strength, viscosity, and pH levels (7.74 ± 0.83 Bloom, $.63 \pm 0.31$ cP and 6.76 ± 0 , respectively). The successful development of halal gelatin that complies with the Halalan Toyyiban standards requires the integration of the principles with scientific approaches. Techniques such as ultrasound-assisted extraction, Fourier-transform infrared spectroscopy (FTIR), and sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) ensures the gelatine produced meets both Islamic law and the necessary quality and safety standards.

In addition to excluding pork, halal foods should be free of alcohol, a requirement that extends to the pharmaceutical industry (with some exceptions). Alcohol-based solvents, animal-derived excipients, and gelatine capsules are widely used in pharmaceuticals, but need to be replaced with halal-compliant alternatives, supported by rigorous scientific

testing. Duopharma Biotech, the world's first halal pharmaceutical manufacturer, leads in developing halal pharmaceuticals. The company adopts a holistic approach by integrating the concept of "halal built-in, not tested for" into its processes (Duopharma Biotech 2024). This principle emphasized that the compliance is embedded throughout the product life cycle, from sourcing raw materials to final production, rather than being assessed only at the end of the manufacturing process.

The cosmetic industry faces challenges in adhering to halal standards, as many formulations contain animal-derived ingredients, alcohols, or non-permissible chemical additives. To address this challenge, cosmetic companies have changed to plant-based, synthetic, and biotechnologically derived alternatives. Nanotechnology has revolutionized the cosmetic industry by enabling delivery of active ingredients at the molecular level. To comply with the principles of halal toyyiban, scientists should ensure halal-compliant raw materials in nanocarriers and nanoemulsions. A wide range of plant-based emulsifiers, including proteins, polysaccharides, phospholipids, and surfactants, supports the formation of these nanoemulsions, ensuring safety and efficacy without compromising halal standards (McClements *et al.* 2021; Azmi *et al.* 2022). From food and pharmaceuticals to cosmetics, the combination of religious adherence and modern science allows industries to meet the growing demand for halal-certified products while maintaining high standards of efficacy and safety.

6 Future Outlook

In recent years, the global market for Halalan Toyyiban products has experienced significant growth. This rapid increase can be attributed to the rising Muslim population and increasing awareness among non-Muslim consumers regarding the advantages of halal certification (Aziz & Chok 2013). Recent industrial developments emphasized the importance of a stronger integration of scientific methodologies with Islamic dietary laws to guarantee the quality, safety, and authenticity of the products.

The rapid advancement and increasing complexity of digital technologies, such as websites, mobile apps, wearable devices, and smartphone applications, have revolutionized the Halalan Toyyiban industry by providing innovative solutions to enhance quality, safety, and consumer engagement. As these technologies continue to evolve, they are becoming useful tools for ensuring that the products meet the highest standards for integrity, transparency, and compliance. The blockchain technology in halal supply chains offers a decentralized and distributed digital ledger for recording transactions across a network of computers in a transparent, secure, and immutable manner. When a block of transactions is added to the blockchain, it cannot be altered or deleted, thereby creating a permanent and tamper-proof record (Zulihuma *et al.* 2022). Tieman & Darun (2017) visualized the halal supply chain as a comprehensive digital ledger that documents every transaction, with new blocks continuously appended in a linear chronological order. All node in the network has access to a copy of the blockchain, which is automatically updated, providing detailed data on the entire supply chain journey from source to consumer. This allows for easy verification by scanning a QR code on the product and ensuring the transparency and authenticity. As the halal industry continues to grow globally, blockchain technology will become increasingly valuable for maintaining high standards for Halalan Toyyiban products.

A promising area for integrating science with Islam principles is in the study and development. Currently, there is a growing focus on conducting multidisciplinary study that integrates various fields, including food science, chemistry, biotechnology, pharmacology, and Islamic jurisprudence (fiqh). This aimed to create groundbreaking halal products adhering to the Halalan Toyyiban standards, especially in the development of new products. A developing concern centers around cultured meat, a highly promising product derived from biotechnology that bypasses certain aspects of animal physiology (Hamdan *et al.* 2018). Another example is the use of an e-nose for halal authentication in different products. The e-nose mimics the human olfactory system and is widely adopted in food analysis. The developed portable electronic tool is very reliable for the detection of EtOH in various beverages, such as alcoholic beverages, isotonic drinks, soft drinks, and fruit juices of different brands sold in Malaysia (Ab Mutalib *et al.* 2013). Through these advances, science and faith converges to ensure Halalan Toyyiban products are not only safe and high-quality, but also compliant with Islamic dietary laws. For consumers, particularly Muslims, this correlation of health standards and religious guidelines is essential for confident consumption.

By combining scientific advancements with the ethical ideals of Halalan Toyyiban, the industry can fulfill the increasing need for products that are not only halal but also untainted, environmentally friendly, and manufactured with high moral standards. This strategy can facilitate the establishment of stronger confidence among consumers, enhance worldwide accessibility of halal products, and establish a more profound correlation between science and faith. Scientists, Islamic scholars, industrial leaders, and regulatory agencies must collaborate tightly to advance these technologies and maintain ideals of safety, quality, and integrity. Collectively, we can shape a future era in which science and faith will harmoniously merge to

produce goods that genuinely adhere to moral principles and contribute to overall welfare.

7 Conclusion

In conclusion, the convergence of scientific methodologies and Islamic principles in Halalan Toyyiban products signified a significant progression in guaranteeing adherence to religious standards and ensuring product safety. Recent advancements in technology, such as DNA-based methods, chromatography, and blockchains, showed great potential for improving traceability and ensuring authenticity in the food, pharmaceutical, and cosmetic sectors. The significance of this integration became increasingly evident as the global market for the products expanded, due to growing awareness and demand. The future held great promise, as advancements in digital technologies and multidisciplinary study opened up new possibilities for ensuring product integrity. Continuous collaboration was necessary among scientists, Islamic scholars, industry leaders, and regulatory agencies to take full advantage of the possibilities of this integration. This collaboration was essential for the complex process of integrating religious obligations with scientific progress.

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Conflict of Interest

The authors declare no conflict of interest.

References

- Ab Mutalib NA, Jaswir I, Akmeliawati Rini. IIUM-Fabricated Portable Electronic Nose for Halal Authentication in Beverages. 2013.
- Abdul Mokti H, Kamri NA, Mohd Balwi MAWF. Tayyiban in Halal Food Production: A Systematic Literature Review. *Journal of Islamic Marketing*. 2024;15(2):397–417.
- Akter K, Khandaker M, Aziz MA, Mahmud S, Morshed MN, Uddin GMS. Halal Food Safety: PCR Based Detection of Porcine DNA in Imported Chocolate. *Asian Food Science Journal*. 2021;20(3):61–71.
- Alipal J, Mohd Pu'ad NAS, Lee TC, Nayan NHM, Sahari N, Basri H, Idris MI, Abdullah HZ. A Review of Gelatin: Properties, Sources, Process, Applications, and Commercialisation. *Materials Today: Proceedings*. 2019;42:240–250.
- Al-Mahmood OA, Fraser AM. Perceived Challenges in Implementing Halal Standards by Halal Certifying Bodies in the United States. *PLOS ONE*. 2023;18(8):e0290774.
- Alzeer J, Rieder U, Hadeed KA. Rational and Practical Aspects of Halal and Tayyib in the Context of Food Safety. *Trends in Food Science & Technology*. 2018;71:264–267.
- Ash ID, Kemala T, Nurilmala M. Halal Gelatin Extraction from Patin Fish Bone (*Pangasius hypophthalmus*) By-product with Ultrasound-Assisted Extraction. *IOP Conference Series: Earth and Environmental Science*. 2019;299(1).
- Aziz YA, Chok NV. The Role of Halal Awareness, Halal Certification, and Marketing Components in Determining Halal Purchase Intention Among Non-Muslims in Malaysia: A Structural Equation Modeling Approach. *Journal of International Food and Agribusiness Marketing*. 2013;25(1):1–23.
- Duopharma Biotech. Halal Initiatives. 2024.
- Hamdan MN, Post MJ, Ramli MA, Mustafa AR. Cultured Meat in Islamic Perspective. *Journal of Religion and Health*. 2018;57(6):2193–2206.
- Lehotay SJ, Hajišlová J. Application of Gas Chromatography in Food Analysis. *Trends in Analytical Chemistry*. 2002;21.
- McClements DJ, Das AK, Dhar P, Nanda PK, Chatterjee N. Nanoemulsion-Based Technologies for Delivering Natural Plant-Based Antimicrobials in Foods. *Frontiers in Sustainable Food Systems*. 2021;5(February):1–23.
- Muflihah, Hardianto A, Kusumaningtyas P, Prabowo S, Hartati YW. DNA-Based Detection of Pork Content in Food. *Heliyon*. 2023;9(3).
- Ng PC, Ahmad Ruslan NAS, Chin LX, Ahmad M, Abu Hanifah S, Abdullah Z, Khor SM. Recent Advances in Halal Food Authentication: Challenges and Strategies. *Journal of Food Science*. 2022;87(1):8–35.
- Nurani LH, Riswanto FDO, Windarsih A, Edityaningrum CA, Guntarti A, Rohman A. Use of Chromatographic-Based Techniques and Chemometrics for Halal Authentication of Food Products: A Review. *International Journal of Food Properties*. 2022;25(1):1399–1416.
- Prachugsorn A, Thanakiatkrai P, Phooplub K, Ouiganon S, Sriaeed Y, Thavarungkul P, Kanatharana P, Buranachai C, Kitpipit T. Detection of Porcine DNA in Food Using Direct Asymmetric PCR and Catalyzed Hairpin Assembly Fluorescent Biosensor: A Novel Assay for Halal Food Analysis. *Food Control*. 2022;139.
- Rohman A, Erwanto Y, Hossain MAM, Rizou M, Aldawoud TMS, Galanakis CM. The Application of DNA-Based Methods for Authentication Analysis: Examples in Halal and Kosher Food Products. *Food Authentication and Traceability*. 2020;195–213.
- Sani MSA, Nordin NFH, Elgharabawy AAM. Halal Detection Technologies: Analytical Method Approaches, Validation and Verification, and Multivariate Data Analysis for Halal Authentication. *Innovation of Food Products in Halal Supply Chain Worldwide*. 2023;253–271.
- Tieman M, Darun MR. Leveraging Blockchain Technology for Halal Supply Chains. *Islam and Civilisational Renewal*. 2017;8(4).
- Von Bargen C, Dojahn J, Waidelich D, Humpf HU, Brockmeyer J. New Sensitive High-Performance Liquid Chromatography-Tandem Mass Spectrometry Method for the Detection of Horse and Pork in Halal Beef. *Journal of Agricultural and Food Chemistry*. 2013;61(49):11986–11994.
- Windarsih A, Bakar NKA, Rohman A, Yuliana ND, Dachriyanus D. Untargeted Metabolomics Using Liquid Chromatography-High Resolution Mass Spectrometry and Chemometrics for Analysis of Non-Halal Meats Adulteration in Beef Meat. *Animal Bioscience*. 2024;37(5):918–928.
- Zulihuma K, Samad A, Shibghatullah B. Halal Supply Chain Management Using Blockchain Technology. 2022.