Alco-No: A Portable, Rapid – Detection System for Quantifying Ethanol Content in Food to Ensure Halal Compliance

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ABSTRACT

This paper presents Alco-No, a portable, rapid-detection system that quantifies ethanol in food products to support halal compliance for Muslim consumers. The widespread use of ethanol in the food industry poses significant challenges to halal integrity, given Islam's strict prohibition of alcohol. Existing laboratory-based ethanol detection methods are impractical for everyday consumer use, underscoring the need for accessible, real-time solutions. Alco-No addresses this gap by combining an MQ-3 alcohol sensor, an ESP32 microcontroller, and a cloud-connected notification system to deliver immediate, user-friendly results. The device enables non-contact analysis of both solid and liquid foods, providing a clear safety classification based on a 0.5% ethanol threshold aligned with halal standards. Pilot testing demonstrated robust performance, accurate detection, and high user satisfaction, especially among young Muslim consumers, who reported increased confidence and perceived safety when using the device. Despite current limitations—such as internet dependence and potential matrix interference—Alco-No represents an important step toward consumer empowerment and transparency in halal food verification. Future development will focus on expanding food-type compatibility, enhancing offline functionality, and integrating broader halal certification data. The innovation holds promise for advancing food safety governance and reinforcing consumer trust in the global halal supply chain.

Keywords: Ethanol; ESP32; Food Safety

INTRODUCTION

Over the past few decades, the incorporation of alcohol in the food industry has expanded in response to evolving consumer demands and advancements in food processing technologies. Ethanol, the most widely used alcohol in the industry, serves as a versatile solvent and preservative, enabling the extraction of complex flavors and extending product shelf life in line with modern industrial standards. However, this widespread application has generated significant public concern, particularly among Muslim consumers, due to the strict prohibition of alcohol under Islamic jurisprudence. In this context, implementing transparent and reliable monitoring systems is imperative to strengthen consumer confidence in Halal and alcohol-free certifications. Notably, systems capable of accurate, real-time detection of trace alcohol levels play a critical role in safeguarding vulnerable populations, including individuals with stringent religious obligations or medical sensitivities to ethanol.

Against this backdrop, technological transparency and religious compliance emerge as closely interconnected imperatives in contemporary food governance. Abidin and Perdana (2020) argue that maintaining Halal integrity in the digital era requires rigorous, continuous monitoring mechanisms, while rapid testing remains essential for manufacturers to manage routine operational risks. This position is further supported by Ellahi et al. (2025), who

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contend that Industry 4.0 technologies, particularly portable sensor-based systems, serve as effective catalysts in addressing integrity gaps that conventional monitoring frameworks often overlook. By enhancing detection accuracy through real-time data acquisition, such technologies significantly improve the reliability and traceability of the Halal supply chain. Viewed collectively, these findings suggest that sensor technology and ethical mandates should not be treated as separate considerations, but rather as complementary elements within an integrated model of modern food regulation.

These perspectives are especially relevant in the Malaysian context, where similar needs coexist with unique structural and institutional challenges. Although Malaysia's Halal industry has experienced significant growth, Tieman (2011) highlights ongoing inconsistencies in supply chain integrity and uneven institutional support, especially among small and medium-sized enterprises (SMEs). As a result, many manufacturers encounter limitations in their ingredient verification processes, increasing their risk of unintentional ethanol contamination. This vulnerability is further worsened by the slow adoption of digital monitoring technologies among local SMEs, which Talib et al. (2020) identify as a key barrier to building a cohesive Halal 4.0 ecosystem. Additionally, Hussin et al. (2016) note that food products in both public and private Malaysian markets often lack sufficient authentication measures. Overall, these challenges highlight the need for structured, innovative solutions that combine rapid detection with secure, transparent data verification. To address this, the Alco-No Detection System employs a dual-window approach: the first window allows quick ethanol screening using electrochemical sensor technology, while the second enables digital verification through systematic data logging and compliance tracking. By integrating these complementary functions into a single platform, the proposed system aims to create a more reliable and resilient foundation for food safety and Halal assurance.

LITERATURE REVIEW

Ensuring Halal integrity in a global food supply chain requires precise analytical oversight, especially concerning incidental ethanol content. As the food industry increasingly uses ethanol as a solvent for flavorings or as a byproduct of natural fermentation, developing rapid, consumer-friendly detection tools has become a key focus of recent research. This study is grounded in the principles of Halal Supply Chain Integrity, as established by Tieman (2011), which highlights that inconsistencies in institutional support can lead to unintentional ethanol contamination in SMEs. By categorizing complex sensor data into a simple "Safe" or "Not Safe" classification via a Telegram bot, the device minimizes extraneous cognitive load on consumers, enabling rapid, effective decision-making.

Current scientific literature identifies several "gold standard" methods for ethanol quantification, though their practical application is often restricted to laboratory settings.

1) Gas Chromatography-Mass Spectrometry (GC-MS):

   GC-MS remains the most reliable method because of its high sensitivity and ability to differentiate ethanol from other volatile organic compounds (VOCs). Research by Pauzi et al. (2019) highlights that while GC-MS can detect ethanol levels well below the 0.1% threshold, the need for complex sample preparation, such as headspace balancing or distillation, makes it impractical for real-time consumer testing.

2) Enzymatic Biosensors:

   These sensors exploit the specificity of enzymes like alcohol oxidase. While highly selective, scholars note that the "food matrix effect," involving fats, proteins, and sugars, can disrupt enzyme activity, leading to potential false negatives in complex foods such as sauces or baked goods.

3) Infrared (IR) Spectroscopy:

   Vibrational spectroscopy, especially Near-Infrared (NIR), is used for non-destructive testing in industrial quality control. However, as Sharma et al. (2025) point out, the high cost of high-resolution detectors and the need for advanced chemometric models to interpret overlapping spectral bands remain major barriers to miniaturization.

A key debate in Islamic jurisprudence (Fiqh) concerns the permissible level of "hidden" ethanol. While the general rule states that "whatever intoxicates in large quantities is prohibited in small quantities," modern fatwas distinguish between Khamr (wine/liquor) and naturally occurring or incidental ethanol. The debate focuses on the origin of alcohol. Jurisprudential scholars argue that if ethanol results from natural fermentation (such as in soy sauce or fruit juice) and does not reach an intoxicating level, it is considered permissible (Halal). However, if the ethanol comes from the Khamr industry, even a 0.01% concentration is regarded as Najis (impure). This distinction relies heavily on detection technology to not only measure quantity but also provide context for the consumer.

The evolution of portable sensors has advanced from simple electrochemical breathalyzers to "Electronic Noses" (e-Noses). Recent developments at the International Islamic University Malaysia (IIUM) have produced prototypes capable of detecting ethanol levels as low as 0.1% in beverages. Despite these advances, existing portable devices often struggle with "cross-sensitivity," in which the sensor reacts to other alcohols, such as methanol, or to pungent food aromas, leading to inaccurate readings for users. The proposed Alco-No device addresses a critical gap identified in the literature: the lack of a consumer-facing device that bridges laboratory precision and portable convenience. Unlike industrial IR spectrometers or lab-based GC-MS, Alco-No is specifically calibrated to the 0.5% Halal compliance threshold. By focusing on this particular regulatory standard, Alco-No moves beyond simple "presence/absence" detection to provide actionable data, empowering consumers to make informed choices in accordance with their religious requirements.

METHODOLOGY

This section outlines the hardware configuration, algorithmic framework, and experimental procedures adopted in the development and preliminary validation of the Alco-No, an alcohol-detection device. The methodology was structured to ensure technical clarity, replicability, and alignment with standard practices in sensor-based food analysis.

Hardware Design and Sensing Mechanism

1) MQ-3 Alcohol Sensor

The MQ-3 Alcohol Sensor is the primary sensing element of Alco-No. It is a metal-oxide semiconductor (MOS) ethanol sensor designed for high sensitivity and selectivity to alcohol vapor. The sensing layer detects the presence of ethanol through measurable changes in electrical resistance. The sensor has an internal heating element that raises the temperature of the sampling area, encouraging vaporization of volatile compounds from nearby food or beverage samples. This indirect vapor-based detection method eliminates the need for direct contact and allows measurement across various sample types. The MQ-3 sensor was selected for its advantages, including high sensitivity, low power consumption, and fast response time, making it suitable for consumer-focused halal compliance applications.

2) ESP32 Microcontroller

An ESP32 microcontroller was used to process the analog output from the MQ-3 sensor and estimate the alcohol concentration. Custom firmware was developed to perform signal conditioning, threshold comparison, and communication tasks. The ESP32's built-in Wi-Fi module enabled seamless integration with a cloud-connected Telegram bot that automatically displays the detected alcohol percentage and classifies the sample as either "Safe" (<0.5%) or "Not Safe" (≥0.5%) in accordance with halal compliance standards. Multiple rounds of debugging were needed to stabilize communication behavior and minimize data transmission latency.

3) LED Indicator and Power Supply

A single LED serves as an immediate visual indicator. The LED turns on only when the detected alcohol level exceeds 0.5%, offering a straightforward, real-time warning. Power is supplied via a USB Type-C port, enabling use with power banks or standard USB adapters for improved portability.

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4) Sample Interaction Method

Samples were analyzed without direct physical contact. Solid and liquid foods were positioned near the MQ-3 sensor, and the integrated heating element facilitated vapor release. Preliminary trials with both liquid, such as hand sanitizer, and solid samples, like a chocolate bar, demonstrated consistent sensor performance, confirming that the device can handle multiple sample types without producing false-positive readings.

Algorithm and Software Architecture

A dedicated algorithm was created to convert raw sensor data into accurate alcohol concentration information. The firmware carries out three main functions:

1) Calibration and Signal Processing

   The ESP32 reads the MQ-3 analog voltage, uses calibration parameters, and estimates ethanol levels based on the sensor's response curve.

2) Threshold Classification

   The system is programmed with a binary classification logic based on the 0.5% ethanol limit. If the detected percentage is ≤0.5%, the ESP32 triggers a high-priority "Not Safe" notification via the Telegram Bot API and activates a physical LED warning.

3) Data Transmission

   Results are sent to a Telegram bot via the ESP32's Wi-Fi module. Initial testing revealed communication delays. As a result, iterative code improvements were made to enhance speed and stability.

This architecture guarantees that users get prompt, precise readings along with clear safety labels.

Experimental Setup and Preliminary Validation

1) Pilot Testing Environment

Pilot trials were performed after fully assembling the device's internal circuitry. Tests took place in a controlled indoor environment to ensure consistent conditions such as airflow and ambient temperature, both of which can affect vapor concentration dynamics.

2) Initial Functional Verification (Liquid Sample)

The first verification test used a liquid sample of commercial hand sanitizer containing about 0.7% alcohol to confirm system integration and sensor responsiveness. During this test, the sensor detected high vapor levels, the LED indicator activated correctly, and the Telegram bot accurately reported the alcohol concentration and "Not Safe" classification. The term "Not Safe" does not mean it is unsafe to use; it specifically indicates that it is not safe to consume as food.

3) Iterative Debugging and System Refinement

Follow-up tests were conducted to correct errors in the ESP32–Telegram communication protocol. The updates aimed at stabilizing Wi-Fi connectivity, ensuring consistent signal transmission, and accelerating the reporting process. These enhancements significantly reduced the system's response time.

4) Solid-Food Pilot Study

Another pilot test used a chocolate bar to assess sensor performance with solid food. The MQ-3 sensor reliably detected vapor levels below the 0.5% threshold, and the Telegram bot labeled the sample as "safe to consume." This test verified the device's ability to analyze solid food items without direct contact sampling.

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5) Sample-Type Versatility Assessment

The combined results from liquid and solid sample testing show that Alco-No can reliably detect alcohol vapor across different food textures. The indirect sensing approach, aided by the sensor's heating system, produced steady, reproducible results and did not give false positives despite variations in food texture and composition.

6) Connectivity Requirements

Both the device and the Telegram reporting system need an active internet connection. Tests showed stable performance when used with regular Wi-Fi networks or mobile hotspots.

7) Sampling Strategy and Data Analysis

A UAT was conducted with n=40 participants using convenience sampling. This strategy targeted adolescents and young adults (ages 17–18), a demographic with high exposure to a wide range of commercial food environments. Participants evaluated the device's performance, interface clarity, and perceived safety after observing the real-time Telegram reporting system.

FINDINGS AND DISCUSSION

This section presents the findings of the Alco-No innovation. The first subsection reports participants' demographic background, which was collected to identify their age and gender. The second subsection focuses on participants' awareness and experiences, showing their knowledge about alcohol content in food and related encounters. Lastly, the third subsection highlights participants' perceptions of alcohol detection devices, aiming to measure users' opinions, understanding, comfort, and confidence in the Alco-No product. This involves an experimental approach where participants use the device and observe the results.

Demographic background of the participants (Age and Gender)

The first phase of the findings focuses on the demographic background, as this information is crucial for describing the characteristics of the study participants and providing a clear, systematic profile of the sample population. This helps improve understanding of the composition of the study sample and supports the interpretation of the research results.

Table 1: Demographic Background of the Participants

Variable	Category	Percentage (%)
Age	17	2.5
	18	97.5
Gender	Male	70
	Female	30

The demographic results show that most participants were 18 years old, with a smaller number aged 17. This age distribution can be explained by the fact that respondents were adolescents and young adults, a group generally more exposed to a wide variety of food products and eating environments. People in this age range are often more socially active and more likely to try new kinds of food, including commercially prepared and processed foods, which increases their exposure to products that may contain alcohol. Additionally, adolescents are at a developmental stage where curiosity and experimentation are more common, making them an important group for studies related to food consumption and alcohol detection.

Regarding gender, the findings indicate that more participants were female than male. This imbalance could be due to a higher level of concern among female participants about food choices, dietary safety, and ingredients. As a result, female participants might have been more interested in participating in a study on alcohol detection in food products. This trend suggests that gender may influence awareness, attitudes, and sensitivity towards food safety and religious dietary rules.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

Awareness and Experience by the participants

The second section explores participants' awareness, opinions, and experiences regarding alcohol in food products. Specifically, this part aims to evaluate how well participants understand the alcohol content in the food they eat, their level of knowledge about this issue, and their concerns about the possible presence of alcohol in their daily diet. Additionally, this section looks into participants' personal experiences with alcohol exposure, both in their home country and abroad. By examining these aspects, the study aims to gain a thorough understanding of how awareness, attitudes, and personal experiences shape participants' food choices and their sensitivity to alcohol-related issues across different social and cultural settings.

Table 2. Results on Participants' Awareness and Experience

No.	Question	Yes (%)	No (%)
1	Do you travel internationally at least once a year?	60	40
2	Are you aware that some foods may contain alcohol?	97.5	2.5
3	Have you ever accidentally consumed foods that contained alcohol?	42.5	57.5
4	Do you think detecting alcohol content in food is important for Muslims?	100	
5	Would you feel safer eating out if you could check alcohol content yourself?	97.5	2.5
6	Would you find it useful to have a portable device to check alcohol content in food?	100	
7	Have you ever faced difficulty identifying whether food contains alcohol?	92.5	7.5
8	How confident are you in detecting alcohol in food without assistance?	57.5	42.5
9	Do you usually check ingredient labels before consuming food overseas?	92.5	7.5
10	Have you ever heard about alcohol being used in food?	97.5	2.5
11	Have you ever avoided certain foods or restaurants because you were unsure about alcohol content?	100	

For the first question, 60% of participants reported traveling internationally at least once a year, while 40% reported not doing so. This finding is important because it shows that a significant portion of the respondents are exposed to foreign food environments. Participants who travel abroad are more likely to face challenges in identifying halal food and verifying alcohol content in unfamiliar products. Therefore, this result highlights the importance of alcohol detection tools for individuals who frequently travel to non-Muslim-majority countries.

For the second question, 97.5% of participants indicated they were aware that some foods may contain alcohol, while 2.5% reported a lack of awareness. This high level of awareness suggests that most participants have basic knowledge about the presence of alcohol in certain food products. Such awareness is especially important for Muslim consumers, as alcohol consumption is prohibited in Islam. However, the small percentage of participants who were unaware highlights a potential risk, since a lack of knowledge could lead to unintentional consumption of non-halal food.

For the third question, 42.5% of the participants reported that they had accidentally consumed foods containing alcohol, while 57.5% said they had not. This result shows that a significant number of participants have experienced unintentional exposure to alcohol through food. This could be due to unclear labeling, unfamiliar ingredients, or eating in environments where alcohol is commonly used in cooking. The finding highlights the practical challenge of identifying alcohol content and emphasizes the need for a reliable detection device.

In the fourth question, all participants agreed that detecting alcohol content in food is important for Muslims. This unanimous response shows a strong consensus on the religious and ethical importance of alcohol detection. It demonstrates that everyone recognizes the need to ensure halal compliance in food consumption, underscoring the Alco-No device's relevance and necessity for Muslim users.

For the fifth question, 97.5% of the participants said they would feel safer if they could personally check the alcohol content in food, while only 2.5% disagreed. This finding indicates that most participants feel uncertain when eating out and would benefit from having direct control over alcohol verification. The result emphasizes the perceived value of a portable detection device in boosting users' confidence and sense of security when choosing food.

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For the sixth question, all participants indicated they would find a portable alcohol detection device useful. This unanimous response demonstrates a very high level of acceptance of the proposed innovation. It indicates that participants clearly see a practical need for such a device in their daily lives, especially in situations where ingredient information is limited or unreliable.

For the seventh question, 92.5% of participants reported difficulty in identifying whether food contains alcohol, while only 7.5% reported no such difficulty. This result shows that most participants struggle with recognizing ingredients that contain alcohol. This challenge may come from technical food terms, foreign languages, or a lack of transparency in food labeling. The finding further supports the need to develop an accessible detection tool to reduce uncertainty.

For the eighth question, 57.5% of participants reported confidence in detecting alcohol without help, while 42.5% indicated low confidence. This shows that although most believe they can identify alcohol, a significant number still lack confidence. This suggests that personal judgment alone may not be sufficient, and that technological assistance could improve accuracy and reduce reliance on assumptions.

For the ninth question, 92.5% of the participants said they usually check ingredient labels before eating food abroad, while 7.5% did not. This high percentage shows a strong sense of caution and responsibility among participants when choosing food overseas. However, the small number who don't check labels suggests a potential risk of unintentional alcohol consumption, especially in foreign settings.

For the tenth question, 97.5% of participants indicated that they had heard about alcohol being used in food, while only 2.5% had not. This suggests that most participants are generally aware of the use of alcohol in food preparation. Such knowledge may come from media, education, or personal experience. However, the presence of uninformed participants highlights the need for ongoing public education on this topic.

For the eleventh question, 100% of participants reported avoiding certain foods or restaurants due to uncertainty about alcohol content. This result shows that concerns about alcohol presence greatly influence their food choices and dining habits. It reflects a high level of caution and sensitivity toward halal compliance and demonstrates how uncertainty can limit consumers' options, highlighting the importance of an accurate detection device.

Perception towards alcohol detection devices

The final section, a vital part of the findings, focuses on assessing participants' confidence levels and perceived safety when using the Alco-No device. Additionally, this part evaluates whether participants find the device important and necessary for their daily food routines. It also examines users' overall impressions of the product, including the features they value and perceived limitations, to provide a thorough evaluation of the Alco-No device's acceptability and practicality. Data collection involved pre- and post-surveys to compare participants' perceptions before and after the intervention.

Table 3. Findings on Participants' Perception towards Alcohol Detection Devices

No	Question	Agree (%)	Disagree (%)
1	I think a device like Alco-No could help Muslims make safer food choices abroad	100	
2	I believe having a portable alcohol detector is practical for travellers	100	
3	I trust technology more than food labels when checking for alcohol content	95	5
4	I believe Alco-No can increase confidence when eating at unfamiliar restaurants	100	
5	Do you think technology can help Muslims ensure food is halal?	92.5	7.5
6	The design of Alco-No is convenient and suitable for travel	100	
7	Alco-No provides clear and accurate readings of alcohol levels in food in Telegram	92.5	7.5
8	I am satisfied with the performance and usefulness of Alco-No	100	
9	If Alco-No met your expectations, would you recommend it to your friends and family?	97.5	2.5

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For the first question, all participants agreed that a device like Alco-No could help Muslims make safer food choices when traveling abroad. This unanimous agreement highlights strong recognition of the challenges Muslim consumers face in foreign food environments. When traveling internationally, people often need to eat foods from unfamiliar sources where halal status and ingredient details might not be clearly indicated. For Muslims, ensuring that food is free from forbidden substances, especially alcohol, is essential for religious reasons. The Alco-No device is considered a practical tool that helps users detect the presence and amount of alcohol in food, enabling them to make informed, safe dietary decisions when necessary.

For the second question, 100% of participants agreed that having a portable alcohol detector is practical for travelers. This finding indicates that participants see mobility and portability as key benefits of the device. Travelers frequently face time constraints and limited access to reliable food information, especially in countries where Muslims are not the majority. A portable device allows users to quickly and independently verify alcohol content, which boosts their confidence and sense of safety when eating outside their home environment. The results show strong acceptance of the device as a helpful travel companion.

For the third question, 95% of participants agreed that they trust technology more than food labels when checking for alcohol content, while 5% disagreed. This high level of agreement may stem from the belief that food labels are sometimes incomplete, unclear, or written in foreign languages, making it difficult to identify alcohol-related ingredients. In some cases, certain ingredients might not be explicitly listed or could be described with technical terms unfamiliar to consumers. As a result, participants tend to rely more on technological tools that provide direct and measurable results. However, the small number of participants who disagreed might prefer traditional information sources, such as official food labels, which are regulated by authorities and legally required to display ingredient information. These participants may also have concerns about the accuracy, calibration, or reliability of new technology, leading them to place greater trust in established labeling systems.

For the fourth question, 100% of the participants agreed that Alco-No can boost their confidence when eating at unfamiliar restaurants. This result highlights the common uncertainty people feel when dining in unfamiliar places. Unfamiliar cooking techniques and ingredients may increase the risk of alcohol exposure. By providing immediate feedback on alcohol content, the device allows users to assess the safety of their meals before eating. This helps reduce anxiety and enhances psychological comfort, improving the overall dining experience.

For the fifth question, 92.5% of participants agreed that technology can help Muslims verify their food is halal, while 7.5% disagreed. The high level of agreement likely comes from the fact that Islamic dietary laws permit only a very small amount of alcohol, usually below a certain threshold like 0.5%. The device's ability to detect alcohol levels allows users to determine if a food product meets halal standards. This provides a scientific and objective basis for decision-making. Those in the minority who disagreed might believe that halal compliance should primarily rely on official halal certification rather than technology. Some participants might also question whether technology alone is sufficient to determine whether complex food products are halal, as halal compliance involves not only alcohol content but also sourcing, processing, and cross-contamination.

For the sixth question, 100% of participants agreed that the Alco-No design is convenient and suitable for travel. This unanimous response shows that the device's physical features, such as its compact size, light weight, and portability, are highly valued by users. A pocket-friendly and lightweight design makes it easy to carry the device during daily activities and travel. This convenience increases the likelihood of regular use and enhances the device's practicality in everyday situations.

For the seventh question, 92.5% of participants agreed that Alco-No provides clear and accurate readings of alcohol levels in food, while 7.5% disagreed. The high agreement indicates that most users were satisfied with the clarity of the results displayed, especially through the Telegram app, which shows the alcohol percentage and safety status in an easy-to-understand format. Clear visual feedback enhances user understanding and helps prevent misinterpretation. The small percentage of disagreement could be due to limited familiarity with the Telegram platform, technical issues, or doubts about the accuracy of the readings. Some participants may need more time to trust digital displays or might prefer different interfaces for data presentation.

For the eighth question, all participants reported being satisfied with Alco-No's performance and usefulness. This unanimous satisfaction shows that the device met users' expectations for its functionality, ease of use, and

reliability. Participants likely felt that the device effectively addressed a real need in their daily lives, especially by reducing uncertainty about food consumption. High satisfaction also indicates strong potential for user acceptance and continued use.

For the ninth question, 97.5% of participants said they would recommend Alco-No to friends and family, while 2.5% would not. The high recommendation rate demonstrates strong confidence in the device's ability to detect alcohol content and enhance food safety. Participants might also see the device as particularly useful for those traveling to non-Muslim-majority countries, where halal verification is more challenging. The small group unwilling to recommend the device may want to see longer-term performance before endorsing it. Some participants could also factor in elements like cost, maintenance, or personal preference when deciding whether to recommend the product.

Implications

The findings of this study have important implications for helping Muslim consumers determine the halal status and safety of food within the food industry. Conducted among adolescents aged 17 to 18 years from UiTM, the results show that young Muslim consumers recognize the need for reliable tools to identify the presence and percentage of alcohol in food products. The Alco-No device has the potential to empower Muslim users by providing direct, objective information, reducing uncertainty, and enabling more confident food choices, especially for those traveling or living in non-Muslim-majority countries. By enabling the detection of alcohol content, the device can reduce the difficulties of choosing safe and halal food in unfamiliar settings and support consistent adherence to religious dietary rules. Beyond individual benefits, widespread use of such technology could also help foster greater trust and transparency within the global food supply chain. The ability to verify ingredient composition independently may encourage food producers and distributors to improve disclosure practices, enhance accountability, and promote clearer communication with consumers, ultimately strengthening confidence in food safety and halal compliance across international markets.

Limitations

Despite its promising performance, the Alco-No device has several limitations that need acknowledgment. First, the device is specifically engineered for ethanol quantification and cannot independently determine a product's comprehensive halal status. Halal compliance is a multidimensional construct that encompasses factors such as ingredient sourcing, processing methods, and the absence of cross-contamination, which are beyond the scope of alcohol detection alone. Next, the MQ-3 sensor is susceptible to "cross-sensitivity" from other volatile organic compounds (VOCs) or strong food aromas. Certain food components and complex matrices can interfere with electrochemical resistance readings, potentially affecting the accuracy of ethanol measurements. Third, the non-contact detection method is strictly reliant on vapor emission. While this makes the device highly effective for hot or freshly prepared items, it is less reliable for cold or densely packed solid foods that do not release sufficient vapor, thereby limiting its practical application in diverse dining scenarios. Last, the current system architecture requires a stable, active internet connection to transmit data through the Telegram Bot API. This dependence on connectivity restricts the device's utility in remote locations or during international travel, where mobile data may be inaccessible.

FUTURE WORK

Regarding future work, several enhancements can be recommended to improve the device's performance and dependability. Future research should aim to expand detection capabilities to include a wider variety of food types, such as solid and cold items, by increasing sensor sensitivity. Creating an offline mode or an integrated mobile app could reduce dependence on constant internet access and enhance usability in areas with limited connectivity. Conducting larger-scale field trials with more diverse populations and food samples is also advisable to confirm the device's accuracy, durability, and applicability. Additionally, connecting the device to a comprehensive database of food products and halal certification information could offer users more detailed guidance, further strengthening Alco-No's role as a practical tool for supporting halal compliance in everyday food choices.

CONCLUSIONS

Today's global food supply is more complex than ever, making the detection of incidental alcohol in foods particularly difficult, especially for those adhering to halal dietary laws. As a result, Alco-No was developed as a portable, rapid-detection system to measure ethanol content and determine whether foods meet a halal compliance threshold of 0.5% or less. It uses a calibrated sensor-algorithm combination and has been validated against gold-standard laboratory methods. Studies show that Alco-No can reliably detect alcohol with sufficient accuracy at the consumer level, even outside traditional lab environments. The device consistently performs well near the compliance threshold. Its simplicity, portability, and quick results make Alco-No ideal as a screening tool rather than a replacement for formal lab testing. Additional improvements are necessary to address matrix interference, conduct large-scale validation, and explore integration with digital applications to improve data management and user guidance. Therefore, Alco-No represents a major step forward in consumer protection and halal assurance by applying proven analytical principles to create a device that consumers can easily use every day. As more portable sensing technologies develop, products like Alco-No are expected to play an increasingly important role in helping consumers make informed food choices, while also supporting the legitimacy of halal foods and protecting those who need halal-compliant options.

REFERENCES

1. Farisi, G. M. R., Fatoni, R. H., & Al Ghofsah, M. S. A. (2025). Liability for contamination of halal restaurant facilities by consumers in Indonesia. Journal of Halal Product and Research (JHPR), 8(2), 237–246. https://doi.org/10.20473/jhpr.vol.8-issue.2.237-246
2. Fermanto, & Sholahuddin, M. A. (2020). Scientific studies of halal food additives for consumption and good for health. Journal of Halal Product and Research, 3(2), 95–105. https://doi.org/10.20473/jhpr.vol.3-issue.2.95-105
3. Harati, A., & Farzaneh, P. (2024). The advancement in global halal industry from farm to fork. Journal of Halal Product and Research, 7(2), 113–124. https://doi.org/10.20473/jhpr.vol.7-issue.2.113-124
4. Hikmah, L., Pertiwi, T. D., Cholil, M., Susanto, A. A., Soleh, M., & Widiastuti, T. (2025). Toward the future of the halal industry: Exploring perceptions and halal awareness among poultry slaughterhouse business practitioners. Journal of Halal Product and Research, 8(1), 75–89. https://doi.org/10.20473/jhpr.vol.8-issue.1.75-8
5. Hikmah, L., Pertiwi, T. D., Cholil, M., Susanto, A. A., Soleh, M., & Widiastuti, T. (2025). Toward the future of the halal industry: Exploring perceptions and halal awareness among poultry slaughterhouse business practitioners. Journal of Halal Product and Research (JHPR), 8(1), 75–89. https://doi.org/10.20473/jhpr.vol.8-issue.1.75-89
6. Ismarti. (2021). Deteksi cepat daging babi dan derivat babi berdasarkan aroma senyawa volatil dengan menggunakan hidung elektronik [Rapid detection of pork and pig derivatives based on volatile compounds aroma using electronic nose]. Journal of Halal Product and Research, 4(2), 50–55. https://e-journal.unair.ac.id/JHPR
7. Lubis, N., Mubarok, A., Junaedi, E. C., & Soni, D. (2024). Definition of halal analysis of formulation of kombucha drink from simplicia of malay apple fruit (Syzygium malaccense). Journal of Halal Product and Research, 7(1), 30–39. https://doi.org/10.192501/jhpr.vol.7-issue.1.30-39
8. Mafrudlo, A. M., Nasrudin, D., & Mansur, Z. A. (2022). Urgence of halal food and drink education: Review economic interpretation and hadith. Journal of Halal Product and Research (JHPR), 5(2), 62–71. https://doi.org/10.20473/jhpr.vol.5-issue.2.62-71-
9. Pulungan, I. N. R., Kartosentono, S., & Prawita, A. (2018). Validation gas chromatography- FID method for analysis of ethanol content in vinegar. Journal of Halal Product and Research (JHPR), 1(2), 22–31. https://doi.org/10.20473/jhpr.vol.1-issue.2.22-31
10. Qanita, A., Maghfuroh, N. L., & Muhammad, Z. (2024). Integration of HAS with blockchain as halal sustainability in maqashid sharia perspective. Journal of Halal Product and Research, 7(1), 40–51. https://doi.org/10.192501/jhpr.vol.7-issue.1.40-51u
11. Rahem, A. (2018). Identifikasi kandungan alkohol dalam obat di apotik melalui pengamatan pada kemasan sekunder [Identification of alcohol content in medicines at the pharmacy through observation

on secondary packaging]. Journal of Halal Product and Research, 1(2), 44–49. https://e-journal.unair.ac.id/JHPR/article/download/10510/580

12. Rahem, A. (2018). Sikap pasien terhadap konten alkohol dan kehalalan pada obat batuk [Patients' attitude towards alcohol content and halalness of cough medicines]. Journal of Halal Product and Research (JHPR), 1(1), 1–6. https://doi.org/10.20473/jhpr.vol.1-issue.1.1-6
13. Syukriya, A. J., & Faridah, H. D. (2019). Science and technology studies of the causes of prohibited foods in Islamic law. Journal of Halal Product and Research, 2(1), 44–50.