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Foreword

Dear Readers,

We are pleased to present the third issue (number) of the Journal for Halal Quality and Certification, which significantly contributes to strengthening the scientific framework for collaboration in the halal industry.

The scientific and professional significance of this journal is reflected in the collection, presentation, and affirmation of scientific, professional, and practical achievements in the field of halal quality certification, as well as the production and processing of halal products. At the same time, it aims to enhance the connection between the academic community, agricultural producers, the food and pharmaceutical industries, and governmental institutions. By presenting knowledge and experience in the field of halal quality, the journal aims to contribute to the development of halal product quality and certification processes.

Indirectly, halal quality improves production and economic growth, thus potentially impacting the quality of life, globally. This effort needs to be strengthened through understanding and cooperation among related parties worldwide in addressing and resolving emerging issues. The Journal is designed to meet the needs of the academic community, researchers, practitioners, policymakers, and both governmental and private agencies in discovering and sharing their knowledge and experiences on current and future issues related to halal quality science.

The printing and online publication of the journal contribute to the development and dissemination of scientific thought and research results in the field of halal quality and certification. The journal is available both online and in print, facilitating easier, faster, and higher quality access for researchers and other interested parties worldwide. The journal aims to integrate halal with other disciplines such as theology, food technology, agronomy, veterinary medicine, medicine, pharmacy, economics, law, and others.

In this issue, we present papers in the areas of: Halal quality certification and accreditation, status and possibilities for improvement, Halal in various segments of industrial products, Halal tourism and gastronomy, Halal quality assurance and management systems, and Hygiene and sanitation in compliance with Halal standards.

Finally, we would like to express our honest thankful to all the authors who contributed to this issue, as well as to the reviewers and all related parties who made this issue of the Journal possible.

In the name of the Editorial board
Sincerely,

Prof. Dr. Sci. Midhat Jasic, Editor-in-Chief
Dr. Sci. Anat Denyingyhot, Guest Editor
Dr. Sci. Damir Alihodzic, Editor

Predgovor

Poštovani čitatelji,

Pred Vama je treće izdanje Časopisa o halal kvaliteti i certificiranju, koji pruža značajan doprinos jačanju naučnog okvira za saradnju u oblasti halal industrije.

Naučni i stručni značaj Časopisa ogleda se kroz prikupljanje, prezentiranje i afirmiranje naučnih, stručnih i praktičnih dostignuća iz oblasti certificiranja halal kvalitete, kao i proizvodnje i prerade halal proizvoda. Istovremeno se nastoji unaprijediti povezivanje akademske zajednice, poljoprivrednih proizvođača, industrije (prehrambene i farmaceutske) te državnih institucija. Prezentiranjem znanja i iskustva iz oblasti halal kvalitete u časopisu nastoji se doprinijeti razvoju kvalitete halal proizvoda kao i postupaka certificiranja.

Indirektno halal kvalitet poboljšava proizvodnju i ekonomski rast te na taj način može globalno utjecati na kvalitetu života ljudi. Ovaj napor treba biti osnažen razumijevanjem i saradnjom među povezanim stranama diljem svijeta u suočavanju i rješavanju problema koji se mogu pojaviti. Časopis je koncipiran kako bi olakšao potrebe akademske zajednice, istraživača, praktičara, kreatora politika, vladinih i privatnih agencija u otkrivanju i dijeljenju njihovog znanja i iskustava u temi trenutnih i budućih pitanja vezanih uz nauku o halal kvaliteti.

Štampanje i on-line objavljivanje časopisa je doprinos razvoju i širenju naučne misli i rezultata istraživanja u području halal kvalitete i certificiranja. Ovaj časopis je dostupan on line, ali i štampanoj formi. To omogućava lakši, brži i kvalitetniji pristup istraživačima i drugim zainteresiranim stranama iz cijelog svijeta. Časopis ima namjeru integrirati halal sa ostalim disciplinama kao što su teologija, prehrambena tehnologija, agronomija, veterina, medicina, farmacija, ekonomija, pravo i druge.

U ovom broju časopisa objavljeni su radovi iz područja: Certifikacije i akreditacije halal kvalitete, status i mogućnosti za poboljšanje, Halal u različitim segmentima industrijskih proizvoda, Halal turizam i gastronomija, Sistem osiguranja i upravljanja halal kvalitetom i Higijena i sanitacija u skladu sa Halalom.

Na kraju, želimo izraziti našu iskrenu zahvalnost svim autorima radova koji su doprinijeli ovom broju, ali i recezentima te svim povezanim stranama koji su učinili da ovaj broj časopisa ugleda svjetlo dana.

U ime uređivačkog odbora
S poštovanjem,

Prof. dr. sci. Midhat Jašić, editor-in-chief
Dr. sci. Anat Denyingyhot, guest editor
Dr. Sci. Damir Alihodzic, urednik

SADRŽAJ / CONTENT

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ACCULTURATION OF THE HALAL CONCEPT AT THE MATIJA GUBEC INTERNATIONAL SCHOOL IN ZAGREB

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Original scientific paper

ABSTRACT

The growing Islamic cultural identity worldwide demands changes and interest across various social fields. With the increasing population of Muslims around the world, there is a rising demand for halal food. It is evident that there is a lack of clear and targeted efforts in educating and acculturating halal culture in European educational systems. At the Matija Gubec International School in Zagreb, meal consumption is a social event that allows students from different religious backgrounds to enjoy meals together without compromising their beliefs. Compliance with halal principles within the food industry is verified through the approval of an accredited certification system, the Halal certificate. For food offered in school kitchens to achieve halal status, it must adhere to strict religious rituals prescribed by Sharia law, ensuring that the production, processing, and handling of food products are in line with Islamic principles. Our school is proud to hold the Halal Certificate, which serves as a guarantee to parents and students of Islamic identity regarding the absence of prohibited components in everyday school meals. Implementing halal food options in schools contributes to creating a stimulating and positive environment for all students regardless of their religious or dietary preferences. The work cites an example of positive experience in acculturating halal food and halal culture into the school environment and the daily lives of students at the Matija Gubec International School.

Keywords: *halal food, halal certification, cultural sensitivity, cultural and religious inclusivity, primary education, center for halal quality certification, halal croatia*

Introduction

Halal, a word that in Islam denotes an action or object permitted by Islamic law (Britannica, 2023). An Arabic term meaning "lawful" or "permissible," it encompasses the fundamental aspects of Islamic dietary regulations derived from the Quran, the holy book of Islam. Although most commonly referring to dietary restrictions, the origin and processing of food, the word halal can be seen in the context of cosmetics, pharmaceuticals, medicine, or tourism. It applies to almost every activity or object of life according to Islamic law. In contrast, the term haram denotes food or actions considered "forbidden" or "prohibited" in the Quran and Hadith (sayings of Muhammad) within Islamic law. Historically, Muslims have followed very different practices regarding food, especially meat, poultry, and fish. The pig is one of the few animals universally

considered haram. Alcohol is also considered haram, although the interpretation of how much alcohol can be consumed historically varies (Britannica, 2023). Haram food encompasses a range of items prohibited by Islamic law, including alcohol, animal products, and meat not slaughtered according to prescribed halal methods. However, Islamic jurisprudence recognizes cases of necessity in which otherwise prohibited items may become permissible for consumption, emphasizing the primacy of preserving life over the strict observance of dietary laws. While certain foods are unequivocally classified as halal or haram, others fall into a gray area of uncertainty, known as mashbooh or "questionable." This ambiguity requires further research to determine their classification. Essentially, halal food encompasses all consumable items that adhere to the principles established in Islamic Sharia law, a comprehensive system governing both personal and collective behavior. Sharia, meaning "path" or "way," determines the moral and legal framework within which Muslims are expected to conduct their lives. Rooted in the teachings of the Quran and the exemplary practice of the Prophet Muhammad, Sharia prescribes permissible and impermissible aspects of human existence, including dietary practices (Bergeaud-Blackler & Bernard, 2010).

Discussion

With the increase in the population of Muslims worldwide, there is a growing demand for halal food. The Muslim population worldwide exceeded 1.7 billion in 2014, and by 2030, it is expected to exceed 2.2 billion, constituting 26.4 percent of the world's population (Park & Lee, 2021). The halal market is therefore growing day by day, with supply and demand in pharmacy, tourism, and the food industry strengthening daily. Furthermore, the halal food market had a value of $2.4 trillion in 2023, and it is estimated to have surpassed $4 trillion by 2030 (State of Global Islamic Economy Report, 2023).[1] The majority of the halal market pertains to the food industry, the production, and export of halal food. Indonesia, as the country with the largest Muslim population (alongside Turkey and Arab countries being the largest users of halal food), interestingly, is not the largest exporter of halal food; instead, wealthier countries like Brazil, India, the United States, and China hold that position. Awareness of the origin of food, processing, and preparation methods makes halal food increasingly popular even in countries without a majority Islamic population that still largely import halal food. Western dietary regulations are not in line with Islamic requirements for halal meat products. The growing expression of Islamic cultural identity in a globalized world and the increasing number of Muslim migrants are driving the spread of halal regimes in Europe and beyond, as well as the production of halal food, which, due to its considerable profit, is often a subject of debate in Western countries (Iner & Baghdadi, 2021). Recent research on the acculturation of halal food suggests several possible factors for successful assimilation in European countries, including (Halawa, 2022): the arrival of Muslim immigrants, the historical colonization of Muslim countries by many former European colonizers, adherence to religious requirements for consuming halal food, cultural and peer influences on the consumption of halal food (especially in schools), perceived control over the consumption of halal meat, the development of cultural identity in the host country, as well as the increasing acceptance of non-Muslim European consumers consuming halal food as a healthier alternative to fast food and processed products.
According to needs, the institutionalized certification of imported and exported halal food products is mostly led by private and non-governmental bodies striving to solidify Islamic dietary codes into national laws (Adams, 2011).

[1] The "State of the Global Islamic Economy Report 2023/2024" is produced by DinarStandard with the support of Dubai Economy and Tourism (DET). This report offers a thorough annual examination of the Islamic economy

For food to achieve halal status, it must adhere to strict religious rituals prescribed by Sharia law. Within the realm of halal food preparation, careful attention is paid to the animal slaughtering process, a practice subject to debate and discussion. Islamic principles dictate that animals should be treated with dignity and compassion, with their lives sacrificed in the name of God in a way that minimizes suffering. This rigorous methodology, often criticized by animal welfare activists, underscores Islam's commitment to the humane treatment of all living beings. This includes adherence to approved certification systems, ensuring that the production, processing, and handling of food products are in line with Islamic principles. Halal certificates, issued by accredited certification bodies, serve as guarantees to consumers of the absence of prohibited components in the food chain (Bergeaud-Blackler and Bernard, 2010).

Despite the increasing prices of agricultural ingredients, the halal food sector continues to thrive, experiencing a remarkable growth rate of 9.75%. It is projected to reach a record high of 5.8 billion USD by 2032. (Imarc Group Market Report, 2023).[2] The halal food market is growing not only due to the Muslim population worldwide but also due to the increasingly common consumption of halal food within non-Muslim populations. It is generally believed that two fundamental factors influence today's global diet: the availability of food and foodstuffs depending on the climatic zone of the inhabitants and the civilizational approach to meal preparation. With the development of civilization, industry, technology, and society, humans have adapted food preparation and processing with specific cultural or religious rituals (Halawa, 2022). Indraw, A.N. and Sur. (2022) discussed halal market users and concluded that non-Muslim populations use halal products because they believe they are correctly processed and handled. Additionally, non-Muslim communities adopt the halal concept through health and hygiene. The authors note that consumers' understanding of the halal concept stems from basic religious education acquired in school. Most respondents stated that they gained basic knowledge of the halal concept in school, resulting in enthusiasm and interest in purchasing halal food (Bashir, 2019; Novitasari and Sur, 2021 in Indraw, A.N., and Sur 2022). It is evident that halal food, as well as the overall halal concept, is becoming increasingly popular among non-Muslim consumers due to its qualities and advantages. Consumers with a strong religious identity seek to follow Islamic law in everyday life, which stimulates increasing discussions on the phenomenon of halal tourism. Aminah and Bhakti (2023) discuss the understanding and support of foreign cultures and ensuring halal products for Muslim tourists. They note that multiculturalism in Japanese halal tourism fails to fully flourish because, for example, many restaurants offer alcoholic beverages, which is considered haram in Islam.

Most foreign, non-Muslim countries can identify with this, although an increasing number of countries supporting halal tourism are taking steps to adapt to the needs of the halal concept. Tourists or migrants who fully accept Islamic law and practice a religious approach to food must adhere to certain dietary restrictions related to food consumption. This includes what food they may or may not eat, food that may or may not be consumed at certain times of the day or year, methods of food preparation and processing, and rules on when and how long to fast. It is understandable that the food market in non-Muslim countries, in terms of restaurants, food chains, retail chains, growers, and food processors, needs to make significant strides in controlling, quality, and origin of foodstuffs. However, given the growing consumption of halal food not only within halal tourism but also among non-Muslim populations, more and more European countries are ready for the process of acculturation of halal food (Halawa, 2022).

Acculturation of Halal Concept in European Schools

The growing Islamic cultural identity worldwide demands changes and interest in various social

[2] IMARC Group provides an analysis of the key trends in each sub-segment of the global halal food market report, along with forecasts at the global and regional level from 2023-2028.

fields. We are witnessing how important it is to raise awareness of the Halal identity at the school level. Not only is there an increasing demand for halal food options in restaurants and food chains, but also in school cafeterias. Due to the religious dietary requirements of Muslim students adhering to halal practices, it is extremely challenging to accommodate religious beliefs given the limited halal food offerings. However, the experiences of students in our school show that many non-Muslim students with specific dietary restrictions or preferences find halal food tasty and inclusive. Often, students in our school desire halal food even when given the choice between another meat-based and vegetarian meal in the school cafeteria. Offering halal food options in schools promotes cultural understanding and inclusion by allowing students from different religious backgrounds to enjoy meals together without compromising their beliefs. The implementation of halal food options in schools can contribute to creating a stimulating and positive environment for all students regardless of their religious or dietary preferences.

Many European countries have attempted to address the acculturation of the halal concept and have made well-intentioned efforts to support the halal market and Islamic adherents by introducing certain changes within various systems. Some countries have been more successful than others, but it is evident that clear and targeted efforts in education and acculturation of halal culture within educational systems are lacking. For example, Spain introduced halal menus on high-speed passenger trains a few years ago by simply removing alcohol and pork from the menu. However, considering the requirements of Islamic dietary laws and halal food processing, it is clear that this was not a sufficient step (Kern, 2011). Belgium faced the problem of hospital patients refusing medication because it contained animal-derived substances, especially during the month of Ramadan. They introduced halal training for hospital staff to better understand and provide care for halal patients. The French food sector doubled its value within a few years because over 80% of animal slaughter is now done according to halal rules, making the process faster, cheaper, and therefore more profitable (Kern, 2011). The same author continues with the example of Italy, which obliges to harmonize Islamic law with certified Italian food products such as tortellini and lasagna. It is known that a school in the Netherlands decided to offer halal food to its students for Christmas to demonstrate acceptance of other religions. Sometimes, such actions and similar ones seem like a positive step towards accepting the halal concept and inclusion of Muslim populations, tourists, or migrants; however, well-intentioned steps can sometimes be offensive to the Islamic community as they are reduced to the profitability of halal users and markets (in terms of earnings or savings if institutions offer halal food). In recent years, since the aforementioned research on the acculturation of halal in European countries, some stronger steps have been taken towards the inclusion of halal users, including in Croatia.

Ensuring Halal Food in Croatian Public Institutions: Government-Islamic Community Agreements and role of Center for Halal Quality Certification.

In 2010, the establishment of the Center for Halal Quality marked a significant milestone in Croatia's efforts to accommodate the dietary needs of its Muslim population. As the sole authorized halal certification body in the Republic of Croatia, the Center plays a pivotal role in ensuring the authenticity and compliance of halal products and services across various sectors.

The certification of the first halal school kitchen at Matija Gubec International School exemplifies the vital role of the Center in promoting inclusivity and diversity within Croatia's educational system. By certifying school kitchens as halal-compliant, the Center enables Muslim students to access meals that align with their religious beliefs, fostering a supportive and inclusive environment for learning. Moreover, the certification of public institutions like schools highlights the commitment of Croatian

authorities to upholding the rights of religious minorities and promoting cultural harmony within society.

In addition to the official recognition of Islam as the state religion in 1916, the signing of the Agreement between the Croatian Government and the Islamic Community in Croatia in 2002 marked a significant milestone in the development of the Islamic Community in Croatia. This agreement addressed issues of common interest and solidified the rights of the Islamic community within the country. One crucial outcome of this agreement was the establishment of the Center for Halal Quality Certification. The agreement safeguards and specifies that the Center for Halal Quality Certification in Croatia holds the exclusive authorization from the Islamic Community of Croatia to define the term "halal" and issue certifications for products and services in accordance with halal standards.

Furthermore, the Agreement also recognized the right to halal food in all public institutions in Croatia. As a result, institutions like the International School Matije Gubec became pioneers in implementing this provision into practice. By offering halal food options, the school demonstrated its commitment to inclusivity and respect for the dietary preferences and religious beliefs of its students and staff, thus setting a positive example for other institutions to follow suit.

Leading the way- Halal Certificate for the first School in Croatia

The Matija Gubec International School in Zagreb has been a proud holder of the Halal certificate since 2015, to the satisfaction of Islamic users of our education program, both students and parents. By pioneering this initiative in Croatia, our school has garnered significant attention, attracting numerous diplomats who have visited to promote its unique commitment to inclusivity. At the Matija Gubec International School, the halal concept is celebrated not only as food in the school cafeteria (which is represented and offered to students on a daily basis), clearly marked with the halal symbol on the school menu but also during International Community Day. The traditional cultural fair held every October provides students of Islamic faith with the opportunity to present their culture, religion, tradition, and food to their non-Muslim friends, but also serves as an opportunity to deepen understanding of halal culture for students and parents of our school. It is therefore not surprising that our school community attracts Muslim families who prioritize halal food for their children's meals, fulfilling their religious dietary requirements. Given the numerous migrations of Islamic populations, the authors discuss the inclusion of the needs of halal users in the daily school menu. Western society is not making sufficient strides towards inclusion; however, teachers encounter practical and ethical issues of students' religion on a daily basis, alongside all other aspects of students' lives, such as developmental and learning difficulties, socioeconomic status of students and parents, student health, family situation, etc. The choice of teaching methods by teachers has a strong impact on students' learning and acquisition and formation of personal identity (Aslan, 2020). Many children only encounter nutrition, religion, and worldviews different from those of their families in kindergarten or school for the first time, which can result in acceptance or rejection of the student within their school community. The teacher plays a strong, perhaps even the most significant role in this (Iversen, 2023). For example, in our school, it is evident that concessions can be made within the micro-community that have resonated strongly beyond the school cafeteria itself. At the request of parents, students can be offered halal meals, vegetarian meals, traditional Croatian dishes containing pork, and, depending on the availability of food and proper processing, gluten-free, lactose-free, and similar necessary diets will be accommodated. It is extremely important to emphasize that these foods are available daily on the school menu, so students with firm religious, cultural, and family beliefs encounter respect for them every day. We asked several students from our school if they were

familiar with halal food and the dietary choices of their friends who opt for halal meals at school. Lara (8) states, "Halal is when people from Azerbaijan cannot eat pork. Some of my friends eat halal, but we also have one who is very picky, but sometimes we manage to persuade him to taste the food. We all eat together at the same table, sometimes we talk." Samra (8) is a consumer of halal meals at school: "I eat halal, and so does my friend from the class. I'm not allowed to eat pork, it's haram. My friend from India is a vegetarian, sometimes we like to eat similar food." Boys Viktor (8) and Emanuel (8) would like to try halal food sometimes: "Halal is when you're not allowed to eat pork. Samra and Aras eat chicken, and sometimes their meat and stew look different. We all eat together, and we like it because we're not separated, and sometimes we laugh together. Sometimes for lunch, we all eat halal, we don't always have to eat our own." Depending on the structure of the class, students celebrate each other and their mutual differences and customs, which does not solely apply to the students' dietary habits. Students of all grades are familiar with the personal choices of their friends, in which parents also actively participate. The teacher within the classroom community of students and parents plays a crucial pedagogical role. The school supports multiculturalism and the coexistence of ethnic and religious diversity by providing non-teaching days for students to celebrate religious holidays and festivities with their families.

Conclusion

At the Matija Gubec International School, the concept of halal is accepted as equally as other cultural and religious aspects of students' lives, as well as parents who are always welcome and important members of our community. Living multiculturalism daily in our school, we uphold the beliefs of each individual student regardless of their religious, national, and family background. Meal consumption in our school is a social event, and no one is excluded. This applies to the daily three school meals for students as well as meals served to parents, teachers, and students during various gatherings. Thus, on the aforementioned International Community Day celebration, not only Western food is emphasized but also halal, along with obligatory traditional Croatian cuisine. The harmony of our differences, traditions, tastes, cultures, and people is precisely what we believe makes our school unique.

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AKULTURACIJA HALAL KONCEPTA U MEĐUNARODNOJ OSNOVNOJ ŠKOLI MATIJE GUPCA U ZAGREBU

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SAŽETAK

Rastući islamski kulturni identitet u svijetu zahtjeva promjene i interes na različitim društvenim poljima. S porastom broja populacije pripadnika islamske religije i kulture diljem svijeta, povećava se i potražnja za halal namirnicama. Evidentno je da nedostaje jasnih i ciljanih pokušaja obrazovanja i akulturacije halal kulture u europskim obrazovnim sustavima. U Međunarodnoj osnovnoj školi Matije Gupca u Zagrebu konzumacija obroka je društveni događaj koji omogućava učenicima različitih religijskih pozadina da uživaju u obrocima zajedno, bez ugrožavanja svojih uvjerenja. Provjera poštivanja halal načela unutar prehrambene industrije provodi se odobrenjem akreditiranog certifikacijskog sustava, Halal certifikata. Da bi hrana ponuđena u školskim kuhinjama postigla status halala, mora se pridržavati strogih religijskih rituala propisanih šerijatskim zakonom, osiguravajući da su proizvodnja, prerada i rukovanje prehrambenim proizvodima usklađeni s islamskim načelima. Naša je škola ponosni nositelj Halal Certifikata koji je jamstvo roditeljima i učenicima islamskog identiteta o odsutnosti zabranjenih komponenti u prehrambenim namirnicama u svakodnevnim školskim obrocima. Implementacija halal opcija hrane u školama doprinosi stvaranju poticajnog i pozitivnog okruženja za sve učenika bez obzira na njihove religijske ili prehrambene preferencije. Rad navodi primjer pozitivnog iskustva akulturacije halal namirnica i halal kulture u školsko okruženje i svakodnevicu učenika Međunarodne osnovne škole Matije Gupca.

Ključne riječi: *Halal, islamska kultura, halal proizvodi i usluge, edukacija, halal kultura*

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LEVERAGING BLOCKCHAIN TECHNOLOGY FOR ENSURING THE INTEGRITY OF HALAL SUPPLY CHAINS: A SYSTEMATIC REVIEW

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Review paper

ABSTRACT

Over the past decade, the demand for halal-certified products and services has grown exponentially in various sectors such as food, cosmetics, pharmaceuticals and finance. Previous academic research has shown that traceability, transparency and certification compliance are the main drivers of halal purchasing behaviour. In practice, however, we have found that traceability, transport and storage, end-to-end chain integrity, different halal systems and lack of IT integration contribute to the disruption of halal supply chains. The characteristics of blockchain technology (i.e. decentralisation, immutability, transparency and cryptographic security) should, on paper, facilitate the tracking and verification of halal products from their origin to the end consumer.

In this paper, we explored the pivotal role of blockchain technology in improving the efficiency and reliability of halal supply chains.

The paper has been designed as a systematic literature review based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology. The review of the relevant academic literature has been further integrated and enriched by other sources such as regulatory frameworks and case studies. In doing so, we aimed to provide an updated theoretical and practical view of the adoption of blockchain technology in the context of the halal supply chain.

Preliminary findings suggest that the use of blockchain-based solutions in halal supply chains would increase visibility, trust and accountability, and consequently foster greater trust among halal consumers. In terms of challenges, scalability issues, interoperability concerns and regulatory hurdles would undoubtedly pose significant hurdles for industry stakeholders.

Keywords: *halal supply chains, blockchain, PRISMA, systematic literature review.*

Introduction

The halal industry encompasses products and services that comply with Islamic law and are therefore defined as halal, which means permissible, as opposed to haram, which means forbidden. Historically, Muslims globally have adhered strictly to consuming only halal products, leading to the development of a thriving market across seven primary sectors: food and beverages, finance, clothing, tourism, media, pharmaceuticals, and cosmetics (Alamsyah *et al.*, 2022).

In 2021, the worldwide expenditure of Muslims across the various sectors amounted to a total of two trillion U.S. dollars, with the halal food and beverage sector representing the largest market for Muslim consumers. Projections indicate that

the global Muslim market could expand to approximately 2.8 trillion dollars by 2025 (Statista, 2024).

In order to assure Muslim consumers of the halal status of products and services, certification bodies play a critical role in verifying manufacturing processes from preparation to distribution. Ultimately, the halal certification logos provide consumers with indicators of compliance with halal guidelines and Shariah principles (Ab Talib *et al.*, 2015; Hew *et al.*, 2020).

Halal supply chains, however, encounter numerous obstacles, such as preserving halal integrity, guaranteeing transparency, and addressing consumer worries regarding trust and authenticity (Novianti *et al.*, 2020). Conventional supply chain difficulties like delayed delivery, mishandling, and contamination become more pronounced within halal supply chains. Moreover, the absence of standardized global halal regulations adds complexity to ensuring halal compliance and integrity (Tieman and Darun, 2017; Tieman *et al.*, 2019; Ali *et al.*, 2021).

In this regard, Blockchain technology is emerging as a potential solution to improve transparency, traceability and integrity in halal supply chains. By leveraging blockchain, halal supply chains can overcome challenges related to traceability, product integrity, transportation, and integration of information systems. The real-time visibility and transparency facilitated by blockchain can address the complexity of halal supply chains and ensure compliance with halal standards (Alamsyah *et al.*, 2022; Tan *et al.*, 2022).

The academic literature on the implementation of blockchain technology in halal food supply chains is still in its infancy, due to the relative novelty of this technological innovation. In accordance with relevant authors, we found that previous research on this topic is indeed quite fragmented, presenting purely theoretical discussions with a relative lack of empirical investigations (Ali *et al.*, 2021; Sultana *et al.*, 2022; Bux *et al.*, 2022). In our opinion, in order to fully understand the potential of blockchain in the context of halal food, it is necessary to present an overall view of the topic so that future research can then focus on a theoretical framework based on practical scenarios.

Therefore, with this work, we aim to provide an up-to-date perspective on the impact of blockchain technology on the halal food supply chain industry. The study is therefore designed as a systematic literature review based on the Prisma approach (Moher *et al.*, 2009) and answers the research question “Can blockchain technology enhance the reliability, traceability and sustainability of Halal foods?”.

The paper is structured as follows: in section 2 we present the theoretical framework to clarify the theoretical underpinnings of the phenomenon under analysis, in section 3 we present the methodology used, and in section 4 we present our results and discussion of the findings.

Theoretical background

Halal Supply Chains (HSCs) are characterized by the integration of Halal principles across all stages of manufacturing, sourcing, distribution, and logistics operations. The following Fig. 1 offers a possible conceptual model of Halal Supply Chain Management (Sulaiman *et al.*, 2018; Novianti *et al.*, 2020).

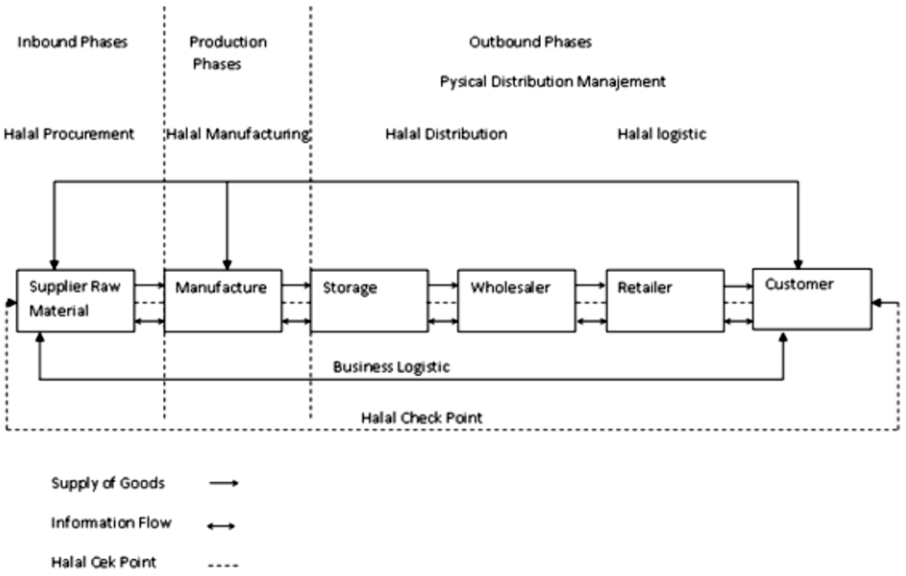

Figure 1. Conceptual Model of Halal Supply Chain Management. Source: Novianti et al. 2020, p. 160

More specifically, we can break down the overall halal production and distribution process into the following three main phases:

1. *Inbound phase (Halal Procurement):* Upon receipt of a Halal certificate, the supplier delivers raw materials for processing by a designated company.
2. *Production phase (Halal Manufacturing)*: These materials are converted into processed food products before being stored in a warehouse for subsequent distribution to wholesalers.
3. *Outbound Phases (Halal distribution /Logistics)*:
    i. After receiving offers and product requests, wholesalers distribute according to wholesale demand.
    ii. The processed products are then distributed to retailers, who market them directly to consumers.

Ideally, every participant in the HSC, including consumers, should be able to verify the halal status of food products through easily accessible checkpoints and transparent information systems across the entire supply chain (Rohmah *et al.*, 2019).

In practice, however, Halal SCs encounter various challenges, including traceability issues, compliance with Shariah requirements, and the lack of standardized certification systems (Surjandari *et al.*, 2021; Tieman *et al.*, 2019).

The key challenges typically encountered in conventional supply chains are exacerbated in Halal SCs, including issues such as cross-contamination, counterfeiting and logistical challenges. This highlights the need for standardised Halal regulations and improved traceability systems (Ali *et al.*, 2017; Tan *et al.*, 2017).

Current track and trace mechanisms used in the halal food industry, including RFID, barcodes and GPS devices, lack real-time visibility, multi-party information sharing and end-to-end transparency. These shortcomings highlight the need for unified, blockchain-enabled solutions that can securely capture and validate data across the supply chain in real time (Tan *et al.*, 2022).

Traditionally, supply chain data has been stored and redistributed through centralized storage architectures. In contrast, blockchain technology operates on distributed systems logic, presenting numerous advantages over centralized systems, such as improved traceability, crucial for identifying the provenance and halal compliance of food items within supply chains (Abeyratne and Monfared, 2016; Ali *et al.*, 2021). Moreover, blockchain technology promises to foster transparent and efficient communication among SC stakeholders and has the potential to promote trust, confidence, and economic growth in the Islamic economy (Chandra *et al.*, 2019).

The definition of "blockchain" continues to spark debate among scholars; some define blockchain as a "distributed data structure, database, or system" while others characterize it as a "decentralized network". For the purposes of this

discussion, we align with the definition suggested by Seebacher and Schüritz in their 2017 paper "Blockchain Technology as an Enabler of Service Systems: A Structured Literature Review":

A blockchain is a distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding timestamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it cannot be altered, turning a blockchain into an immutable record of past activity (Seebacher and Schüritz, 2017, p. 3).

In particular, a blockchain offers a decentralised approach in which transactions between parties are securely and permanently recorded, facilitating the sharing of databases between multiple parties and eliminating the need for intermediaries who have traditionally verified, recorded and coordinated transactions. Centralised authorities are therefore rendered redundant, and blockchain forms a cornerstone of what has been described as a "trust machine" (Rohmah *et al.*, 2019).

Although blockchain technology was initially adopted primarily by the financial industry, it has now spread to various sectors and applications, including global container carriers, fraud detection systems for luxury goods, multinational retail companies and pharmaceutical distribution (Ziegler and Uli, 2021). It is also highlighted that the implementation of blockchain in various industries often requires complementary technologies, in particular the Internet of Things (IoT), especially in the food and logistics sectors, where the convergence of blockchain and IoT systems can promote transparency and consumer confidence in asset traceability (Alamsyah *et al.*, 2022). Blockchain technology also has the potential to offer unprecedented track-and-trace capabilities if the blockchain architecture also integrates smart contracts, namely digital contracts that are stored on the blockchain and automatically executed when certain conditions are met (Rohmah *et al.*, 2019). Vivaldini (2021) maintained that smart contracts play a pivotal role in automating quality control processes in supply chains, thereby minimizing error records (Vivaldini, 2021).

Agency theory supports the adoption of blockchain in the context of halal supply chain management since moving from a centralised to a decentralised system enhances traceability and data transparency, further strengthening the benefits of blockchain adoption (Ali *et al.*, 2021; Tan *et al.*, 2022; Novianti *et al.*, 2020). Surjandari *et al.* (2021) found that combining blockchain technology with halal certification can mitigate key challenges in halal supply chains, namely contamination and disobedience. Tan *et al.* (2022) highlighted that current track and trace solutions for halal supply chains based on traditional technologies (e.g. barcodes, RFID and GPS devices) lack real-time visibility, whereas blockchain technology could enable effective and efficient real-time data collection and secure access throughout the supply chain.

In conclusion, the adoption of blockchain technology offers unprecedented opportunities for enhancing transparency, traceability, and trust in halal supply chains. By embracing blockchain-based solutions, the halal food industry can revolutionize its approach to product management, thereby promoting credibility, trust, and sustainable growth in the Islamic economy.

Methodology

To provide a comprehensive analysis of the phenomenon under analysis, i.e. the impact of the blockchain technology on halal supply chain, we conducted a systematic literature review (SLR) following the guidelines outlined in the PRISMA Statement (Moher *et al.*, 2009). This methodology involves four key steps: identification, screening, eligibility, and, in the case of meta-analyses, inclusion.

The following Figure 2 exemplifies the PRISMA statement approach we adopted, demonstrating the structured process followed in this study.

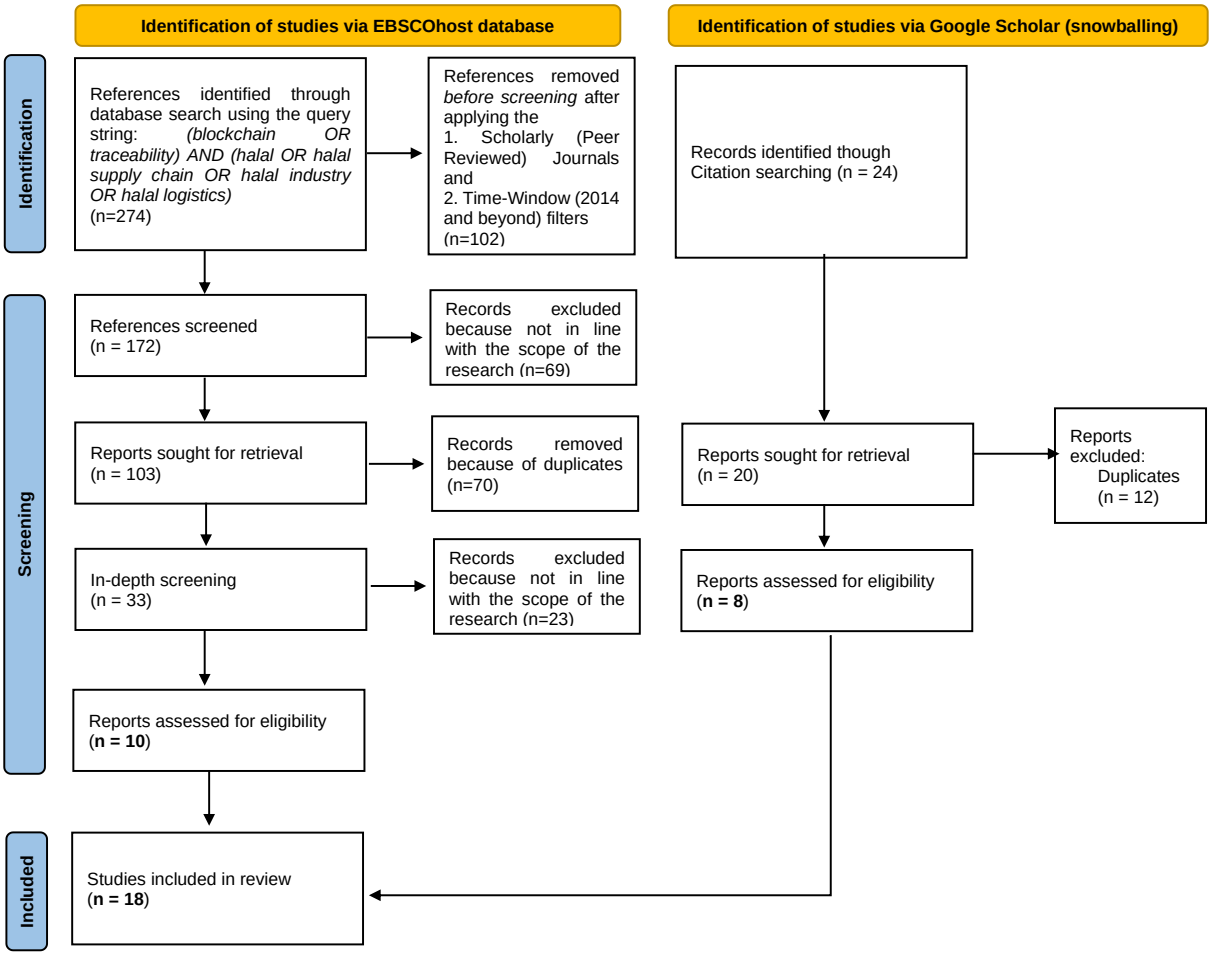

Figure 2 Mapping citations result with PRISMA information flow

Initially, we formulated a search strategy by selecting relevant keywords aligned with our research focus. After conducting preliminary investigations and consulting with experts in the field, we crafted the following query string: (*blockchain* OR *traceability*) AND (*halal* OR *halal supply chain* OR *halal industry* OR *halal logistics*). This string was then employed in eight permutations within the Business Source Premier database (via EBSCOhost), yielding a total of 382 results.

To ensure the quality and relevance of the retrieved references, we applied two filters within EBSCOhost:

- *Scholarly (Peer Reviewed) Journals*: By exclusively selecting papers that had undergone rigorous peer review, we aimed to enhance the reliability of our findings.
- *Time-window*: Although the novelty of the topic could theoretically control for earlier publications, we further refined our search by excluding references older than 2014 to maintain result consistency.

These filters significantly reduced the number of results to 172. Subsequently, in the screening phase, we scrutinized the abstracts of these references to assess their substantive relevance, resulting in 103 relevant papers. Further research on Google Scholar and citation searching of these papers yielded an additional 20 references.

In the eligibility phase, we removed duplicates and thoroughly examined the remaining papers to confirm their suitability for inclusion in our systematic literature review. Ultimately, 18 papers were selected for consideration and review. These papers were managed and coded using Citavi 6.0, serving both as reference management software and as a tool for identifying thematic patterns.

Results and discussion

The following Table 1 exemplifies the relevant papers that form the basis of our analysis. In the next sections, we will discuss the implications of these papers in details.

Table 1 Blockchain and Halal Supply Chain Management

No	Author(s)	Title	Research type	Topic
1.	Asnan *et al.*, 2024	Mapping the Future of Halal Supply Chain Management: A Biblioshiny R Application	Bibliometric Analysis	This research aimed to analyze halal supply chain management publications and visualize the emergent trend for future publication.
2.	Hendayani and Fernando, 2023	Adoption of blockchain technology to improve Halal supply chain performance and competitiveness	Quantitative	This study aimed to investigate the relationship between blockchain technology adoption and firm competitiveness through Halal supply chain performance as a mediating variable.
3.	Purusottoma *et al.*, 2023	Exploring the potential of blockchain adoption for promoting value innovation: a case of the halal industry	Empirical	The study developed a typology model that describes the blockchain adoption for value innovation in the halal industry in Indonesia.
4.	Alamsyah *et al.*, 2022	Blockchain-Based Traceability System to Support the Indonesian Halal Supply Chain Ecosystem	Theoretical	The authors proposed a blockchain-based halal traceability system model specific for the halal meat supply chain.
5.	Bux *et al.*, 2022	Halal Food Sustainability between Certification and Blockchain: A Review	Literature review	This literature reviewed investigates halal food sustainability, examining the barriers and opportunities offered by the certification and blockchain tools.
6.	Sumarliah *et al.*, 2022	Blockchain-empowered halal fashion traceability system in Indonesia	Quantitative	The research examined the participation intent in blockchain-empowered Halal fashion traceability (BHFT) system.
7.	Tan *et al.*, 2022	Applying Blockchain for Halal food traceability	Theoretical	The authors proposed a traceability framework built on Blockchain derived from real-life blockchain implementation in three distinct halal supply chains.
8.	Ali *et al.*, 2021	A sustainable Blockchain framework for the halal food supply chain: Lessons from Malaysia	Theoretical	The authors proposed a novel sustainable blockchain framework for the halal food supply chain that can be used to enhance the supply chain integrity.
9.	Surjandari *et al.*, 2021	Designing a Permissioned Blockchain Network for the Halal Industry using Hyperledger Fabric with multiple channels and the raft consensus mechanism	Experimental / Simulation	The study usesd a Blockchain Network with three channels and used raft consensus algorithm to test their capabilities.
10.	Hew *et al.*, 2020	The blockchain-based Halal traceability systems: a hype or reality?	Quantitative	The study proposes an integrated model aimed at explaining the variance in intention to participate in a blockchain-based Halal traceability system.

11.	Novianti et al., 2020	Designing a Transparent Distributed Systems for Halal Supply Chains Using Blockchain Technology	Theoretical	The paper proposes a distributed system for tracing halal food along its supply chains using blockchain technology.
12.	Vanany *et al.*, 2020	Indonesian halal food integrity: Blockchain platform	Theoretical	Conceptual framework using a specific blockchain architecture, namely Hyperledger fabric, to investigate Indonesian halal food integrity.
13.	Zainal Abidin and Putera Perdana, 2020	A Proposed Conceptual Framework for Blockchain Technology in Halal Food Product Verification	Theoretical	The study presents a framework for blockchain technology for Halal product verification for manufactured food products.
14.	Chandra *et al.*, 2019	Blockchain Redefining: The Halal Food Sector	Experimental	The authors provide a demonstration on how the blockchain technology would shape the halal food supply chain through the hyperledger fabric composer architecture.
15.	Rohmah *et al.*, 2019	Traceability and Tracking Systems of Halal Food Using Blockchain Technology to Improve Food Industry Competitiveness	Theoretical	Conceptual framework of halal food traceability and tracking system using blockchain technology and its impact on food industry competitiveness.
16.	Tieman *et al.*, 2019	Utilizing Blockchain Technology to Enhance Halal Integrity: The Perspectives of Halal Certification Bodies	Theoretical	The paper offers the specific perspective of halal certification toward blockchain technology to improve halal integrity.
17.	Rejeb, 2018	Halal meat supply chain traceability based on HACCP, blockchain and internet of things	Theoretical	The paper suggests a halal meat supply chain traceability system based on HACCP, blockchain and Internet of Things.
18.	Tieman and Ridzuan, 2017	Leveraging blockchain technology for halal supply chains	Theoretical/ Exploratory	The authors provide an overview about the impact of blockchain on halal supply chains providing the basic design principles of blockchain-based HSCs.

Hasnan *et al.* (2024) confirmed the centrality and importance of the impact of blockchain on Halal Supply Chain Management (HSCM). Their thematic map concerning the future trajectory of HSCM delineates four distinct quadrants: i. emerging/declining themes, ii. basic themes, iii. niche themes and iv. motor themes. Notably, the motor theme stands out as a pivotal axis characterized by high significant relevance and high development. This category encompasses pivotal topics including blockchain technology, traceability systems, halal orientation strategy, sustainability, contamination, and Fiqh (Islamic jurisprudence) concerns.

The numerous benefits associated with the adoption of blockchain technology in the context of HSCM have been largely discussed in previous works (Ali *et al.*, 2021; Chandra *et al.*, 2019; Tan *et al.*, 2022; Hendayani and Fernando, 2023; Köhler and Pizzol, 2020), namely:

1. Ensuring the integrity of products and transactions for end consumers through digitalization of halal certificates;
2. Achieving significant cost savings in certification, ranging from 70% to 90%;
3. Streamlining complexity and costs while enhancing capabilities, thus fostering competitive advantage;
4. Facilitating change management and alleviating external pressures;
5. Promoting the adoption of sustainable Halal production and consumption practices.

At the same time, the adoption of blockchain technology also presents potential challenges (e.g. Chandra *et al.*, 2019; Tieman *et al.*, 2019;

Hew *et al.*, 2020; Rahman *et al.*, 2020; Majeed *et al.*, 2021), including:

1. Data privacy and confidentiality: Balancing blockchain's transparency and immutability features with data privacy regulations, such as the General Data Protection Regulation (GDPR) in Europe, which emphasizes customers' right to data erasure.
2. Interoperability/integration: Integrating blockchain into existing supply chain systems requires interoperability with different pre-existing technologies.
3. Scalability and performance: Blockchain scalability is a critical consideration for halal supply chains with high transaction volumes.
4. Cost and resource constraints: Collaborative models can help reduce costs in blockchain projects and foster adoption, especially among SMEs.
5. Regulatory compliance: Blockchain solutions must align with regulatory requirements to ensure compliance.
6. Education and awareness: Education and training programs for different stakeholders are pivotal to facilitate adoption across halal supply chains.

Other relevant challenges specific for halal supply chains are: i. the absence of a global halal certification, leading to inconsistent practices across global halal supply chains (Ab Talib, Mohamed *et al.*, 2017), ii. the presence of inaccurate and unauthentic data concerning Halal products (Ab Talib *et al.*, 2015), iii. inadequate regulation of raw materials for Halal products, partially addressed by the use of the halal logo (Tan *et al.*, 2022), and iv. the ineffectiveness of existing traceability systems, such as RFID or barcode (Norman *et al.*, 2009).

In the literature, four types of blockchain have been categorized based on permission levels (e.g., permissioned or permissionless) and accessibility (e.g., private or public) (Ziegler and Uli, 2021). Tan *et al.* (2022) suggested employing a private permissionless blockchain system to enhance halal integrity. In this regard, Surjandari *et al.* (2021) conducted a simulation in which a permissioned blockchain emerges as an architecture that meets the requirements of global HSCs. Since it is permissioned, administrators can define specific permissions for each participant and, consequently, data visibility. As such, regulators will play a pivotal role in setting such permissions.

A noteworthy model for halal traceability within Indonesia's meat supply chain has been proposed by Alamsyah *et al.* (2022). Their model builds upon earlier conceptual frameworks, specifically focusing on: i) reducing the number of participants within the blockchain network (Rejeb, 2018), ii. establishing a permissioned or private blockchain ecosystem (Novianti *et al.*, 2020), and iii) engaging halal bodies (Surjandari *et al.*, 2021). The Avalanche platform has emerged as the preferred blockchain architecture due to its rapid block creation, cost-effectiveness compared to alternatives (such as Ethereum, Cardano, etc.), support for permissioned blockchains (requiring each actor/stakeholder to obtain licensing for network operation), and accommodation of diverse stakeholder types.

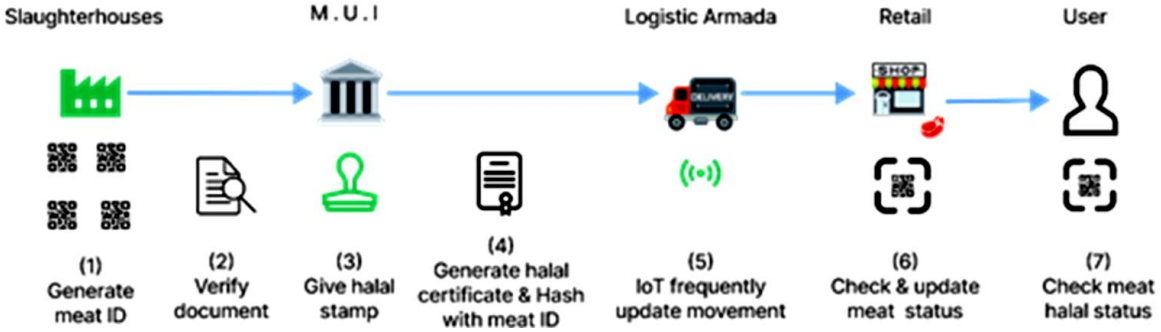

Figure 3 Blockchain process in halal meat distribution. Source: Surjandari et al. 2021

Figure 3 illustrates a potential blockchain process for halal meat distribution in Indonesia. Initially, meat is labelled with a unique ID at the slaughterhouse, which is then uploaded to the blockchain network. Subsequently, the Majelis Ulama Indonesia Institute for Food and Drug Studies and Cosmetics (LPPOM MUI), following document verification, affixes the halal stamp and records an IPFS address on the blocks alongside the MUI's certification. Upon completion of this validation process, distribution commences, with the block regularly updated to reflect handovers until the shipment reaches the retailer. The retailer, in turn, scans a QR code to verify the meat's status, and ultimately, consumers can verify the halal status of the product through the same QR code. A similar foundational framework, albeit applied within a broader context of food supply chains, has also been developed by Novianti *et al.*, 2020, Bux *et al.* (2022), and Tan *et al.* (2022).

It is worth noting that, currently, Indonesia's halal food system relies entirely on halal certificates and labels overseen by LPPOM MUI. Consumers have no immediate access to detailed information and this lack of transparency highlights therefore the need for improved traceability mechanisms (Zainal Abidin and Putera Perdana, 2020).

Conclusion

Yet halal supply chains face numerous challenges, including maintaining halal integrity, ensuring transparency and addressing consumer concerns about trust and authenticity.

Blockchain technology is emerging as a promising remedy to these challenges by enhancing transparency, traceability and integrity within halal supply chains. However, the academic literature on its implementation in this area remains relatively sparse and fragmented, with a lack of empirical research. Our study aimed to provide a current perspective on the impact of blockchain technology on the halal food supply chain industry.

The adoption of blockchain technology offers unparalleled opportunities to improve transparency, traceability and trust in halal supply chains. The adoption of blockchain-based solutions has the potential to revolutionise product management in the halal food industry, thereby promoting credibility, trust and sustainable growth in the Islamic economy.

One notable limitation of our study pertains to the novelty of the topic. However, while we recognize the necessity for further development in empirical and experimental literature, the key findings and insights discussed appear consistent across the range of references analyzed.

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KORIŠTENJE BLOCKCHAIN TEHNOLOGIJE ZA OSIGURANJE INTEGRITETA HALAL LANACA OPSKRBE: SISTEMATSKI PREGLED

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Pregledni rad

SAŽETAK

U protekloj deceniji, potražnja za halal certificiranim proizvodima i uslugama eksponencijalno je rasla u različitim sektorima kao što su hrana, kozmetika, farmaceutski proizvodi i finansije. Prethodna akademska istraživanja su pokazala da su sljedivost, transparentnost i usklađenost sa certifikatima glavni pokretači ponašanja prilikom halal kupovine. U praksi smo, međutim, otkrili da sljedivost, transport i skladištenje, integritet lanca od kraja do kraja, različiti halal sistemi i nedostatak IT integracije doprinose prekidu halal lanaca snabdijevanja. Karakteristike blockchain tehnologije (tj. decentralizacija, nepromjenjivost, transparentnost i kriptografska sigurnost) trebale bi, na papiru, olakšati praćenje i verifikaciju halal proizvoda od njihovog porijekla do krajnjeg potrošača.
U ovom radu istražujemo ključnu ulogu blockchain tehnologije u poboljšanju efikasnosti i pouzdanosti halal lanaca opskrbe.
Rad je osmišljen kao sistematski pregled literature zasnovan na PRISMA metodologiji (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Pregled relevantne akademske literature dodatno je integrisan i obogaćen drugim izvorima kao što su regulatorni okviri i studije slučaja. Čineći to, cilj nam je pružiti ažurirani teorijski i praktični pogled na usvajanje blockchain tehnologije u kontekstu halal lanca opskrbe.
Preliminarni nalazi sugeriraju da bi korištenje rješenja zasnovanih na blockchain-u u halal lancima opskrbe povećalo vidljivost, povjerenje i odgovornost, te posljedično podstaklo veće povjerenje među halal potrošačima. Što se tiče izazova, pitanja skalabilnosti, interoperabilnosti i regulatornih prepreka nesumnjivo bi predstavljale značajne prepreke za zainteresirane strane u industriji.

Ključne riječi: *halal lanci nabavke, blockchain, PRISMA, sistemski pregled*

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DO WE NEED EUROPEAN HALAL ACCREDITATION AGENCY?

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Professional paper

ABSTRACT

In the last decade we are witnessing the development of halal standards for food, bodies providing halal certification and bodies providing halal accreditation. The most important institution which is publishing halal standards is The Standards and Metrology Institute for Islamic Countries (SMIIC) and in the terms of halal accreditaion they published OIC/SMIIC 2:2019_Conformity Assessment – Requirements for Bodies Providing Halal Certification and OIC/SMIIC 3:2019_Conformity Assessment - Requirements for Halal Accreditation Bodies Accrediting Halal Conformity Assessment Bodies. Countries such as UAE and Türkiye has implemented this standard as their national standards and start to issuing halal accreditation for halal certification bodies. The missing part is that halal certification bodies if want to be accredited in both mentioned countries shall go for accreditaion in each country.

The huge step was made by Organization of Islamic Cooperation (OIC) by establishing Islamic Forum for Halal Accreditation Bodies (IFHAB) with the aim that halal accreditation for a halal certification body in one of the OIC member countries, shall be mutual recognize between member countries.

However, the major challenge on the EU halal market is the lack of clear regulatory frameworks of halal certification, standardization and accreditation even the most important halal certification bodies are halal accredited according to above mentioned standards the questions which are still remains are:

1. the self-proclamation of halal for the food and services,
2. halal certification without accreditation for EU market,
3. supervision of halal food which has been imported from OIC countries and others in EU.

The aim of this paper is to analyze the need for establishing European Halal Accreditation Agency using secondary sources and the author's previous research.

Keywords: *halal certification, halal accreditation, EU halal market.*

1. Introduction

Accreditation, as defined by the International Accreditation Forum (IAF) is the process of independently evaluating conformity assessment bodies against recognized standards. Its primary objective is to ensure the impartiality and competence of these bodies to perform specific activities such as tests, calibrations, inspections, and certifications. Accreditation bodies, established in various countries, play a crucial role in overseeing conformity assessment bodies,

thereby maintaining the integrity and reliability of their operations. (IAF, 2024)

2. Halal accreditation

Accreditation of halal certification bodies, as it is often called today, halal accreditation, which emerged as a necessity on the market, got its outlines with the creation of the first standard for Conformity Assessment - Requirements for Halal Accreditation Bodies Accrediting Halal Conformity Assessment Bodies in 2011 as result of study of the Standardization Expert Group by Organization of Islamic Cooperation and International Islamic Fiqh Academy. These standards have been adopted by The Standards and Metrology Institute for Islamic Countries (SMIIC) after its establishment in 2010 and the new edition of standard has been published in 2019. (SMIIC, 2019).

In the terms of history of halal accreditation, it is worth to mention the establishments of International Halal Accreditation Forum (IHAF) in 2013 in Istanbul with the moto: One Standard, one Conformity Assessment System (Certification and Accreditation). The IHAF 2013 was the first organization which emphasizes discussion of mutual recognition of halal accreditation and certification among the potential stakeholders.

In 2016 in Dubai new *International Halal Accreditation Forum (IHAF) as an independent, non-government network of accreditation agencies all mandated to enforce halal standards in their countries and regions was founded by* 10 institutions: Dubai Municipality (Dubai Accreditation Center), Emirates Authority for Standardization and Metrology (Emirates National Accreditation System), American Association for Laboratory Accreditation, Pakistan National Accreditation Council, Entidad Nacional de Acreditacion (Spain), GCC Accreditation Centre, Saudi Accreditation Committee, United Kingdom Accreditation Service, Joint Accreditation System of Australia and New Zealand, and the National Council for Accreditation Egypt (Emirates News Agency, 2016).

Both institutions are currently inactive. In the UAE, Ministry of Industry and Advanced Technology is in charge for registration of halal certification bodies after they finish halal accreditation process by one of the 15 approved accreditation bodies listed on the Ministry website (MOIAT, 2024).

The significant stride toward harmonizing halal certification and accreditation was achieved by the Standards and Metrology Institute for Islamic Countries (SMIIC) through the publication of OIC/SMIIC 2:2019 and OIC/SMIIC 3:2019 standards. OIC/SMIIC 3:2019 delineates the general requirements for halal accreditation bodies (HABs) accrediting halal conformity assessment bodies (HCABs). Rooted in Sharia Law and ISO IEC 17011, alongside other pertinent ISO standards, this standard sets a comprehensive framework for ensuring the integrity and reliability of halal accreditation processes. Furthermore, the standard establishes evaluation mechanisms aimed at regional and international levels within the OIC framework. These mechanisms serve to ascertain that HABs operate in strict adherence to the prescribed standards. Successful completion of such evaluations enables HABs to participate in mutual recognition arrangements within the OIC. Regular re-evaluations are integral to maintaining continued adherence to the established standards. These arrangements facilitate a streamlined process for recognition, promotion, and acceptance of each other's accredited conformity assessment bodies for halal certification. Through this concerted effort, the OIC aims to establish a unified and efficient system for halal certification and accreditation across its member states (SMIIC, 2019).

The establishment of the Islamic Forum for Halal Accreditation Bodies (IFHAB) marks a significant milestone in advancing mutual recognition of halal accredited certification bodies within the Organization of Islamic Cooperation (OIC) countries. IFHAB's mission is to implement a transparent and robust system for halal products and services, aligned with Sharia principles and international technical requirements. This endeavor entails enhancing the quality infrastructure across OIC member

countries, collaborating closely with the Standards and Metrology Institute for Islamic Countries (SMIIC), and fostering a culture of continuous improvement within IFHAB's operations. One of IFHAB's key objectives is to ensure the representation of diverse stakeholders, including accreditation bodies, conformity assessment bodies, legislators, consumers, and others. By fostering inclusivity and collaboration, IFHAB aims to promote consensus-building and drive the adoption of unified halal standards across the OIC. Moreover, IFHAB seeks to capitalize on the economic potential of the halal industry by facilitating international trade and creating new employment opportunities. Through its initiatives, IFHAB aims to position Islamic countries as leaders in halal certification and accreditation, thereby solidifying their influence both regionally and globally. In summary, IFHAB's establishment underscores the commitment of OIC countries to elevate the halal industry to new heights, while also promoting unity, innovation, and economic growth within the Islamic world (HalalFocus, 2023).

3. EU Halal market

The Halal Food and Beverage market in Europe has experienced remarkable growth in recent years, as highlighted in a report by Bonafide Research titled "Halal Food and Beverage Market Outlook in Europe to 2027." According to the report, the market surged by US$29 billion between 2016 and 2021, with further growth anticipated at an annual rate of 6% to 7% until 2027. Halal meat, poultry, and seafood products remain the most sought-after items, reflecting consumers' preference for ethically sourced and halal-certified options. However, other product categories such as bakery, confectionery, and snacks are witnessing rapid growth, with an annual increase of nearly 8%. Key players driving this growth include Nestle SA, Ferrero International SA, KQF Foods, JAB Holding Company, and Tahira Foods. These companies contribute significantly to the market's expansion by offering a diverse range of halal-certified products to meet consumer demand. Retail chains such as Tesco, Sainsbury's, Marks & Spencer, and Waitrose play a pivotal role in catering to consumers' halal needs. They offer a wide selection of halal food items, including meat, sweets, bread, cereals, and snacks, thereby enhancing accessibility and convenience for consumers across Europe.

Several factors contribute to the dynamic growth of the halal market in Europe. These include the increasing Muslim population, multiculturalism, and globalization, which have led to greater awareness and demand for halal products. Additionally, health and safety concerns, coupled with strict standardization measures and effective digital marketing strategies, have further fueled the market's expansion. Overall, the Halal Food and Beverage market in Europe presents significant opportunities for businesses to capitalize on the growing demand for halal-certified products. By understanding consumer preferences and adhering to stringent halal standards, companies can position themselves for success in this burgeoning market (Bonafide Research, 2022).

4. Challenges on the market

The European Union (EU) halal market faces several challenges despite being a significant exporter of halal products. How much important exporter of halal products are EU countries witness for example, Saudi Arabia which imports about 80% of its food requirement from the EU countries and the fact that the 40% of the registered halal certification bodies by the UAE Ministry of Industry and Advanced Technology are from EU (MOIAT,2024).

The key challenges in the EU halal market:

1. Recognition of Islam: In Austria, Belgium, Spain and Croatia, Islam is recognized as an equal religion, while in other member countries it is not.
2. National Organization of Islamic Communities: Islamic communities within the EU are organized on a national basis, which complicates the standardization and

interpretation of halal regulations. The diverse interpretations of halal and varying levels of acceptance of standards among believers pose challenges for halal standardization efforts.

3. Lack of Official Halal Standard: Official registration of halal standards for food is limited to only a few EU countries, such as Austria and Croatia. The absence of standardized halal regulations across all member states creates inconsistency and ambiguity in the halal market.
4. Lack of Accreditation: There is currently no formal halal accreditation system for the EU market. This absence of clear criteria results in the proliferation of halal certification bodies without proper oversight. As a result, there are instances where products are falsely labeled as halal, leading to consumer confusion and potential harm. It is not possible to determine the number of halal certification bodies in the member countries that are engaged in issuing halal certificates. The positive examples are the halal certification bodies operates in EU more than 40 years which are halal accredited by halal accreditation body in some Muslim majority country.
5. Self-Proclamation of Halal: In many shops, butchers or restaurants in the member countries, the mark halal or the word halal stands out in order to attract consumers, however, in most of them the certification procedure has not been carried out and they are not holders of a valid halal certificate.
6. Import Regulation and Supervision: The importation of halal products from Organization of Islamic Cooperation (OIC) countries into the EU highlights the need for robust regulation and supervision. While many imported products are halal certified, there is often inadequate verification or accreditation, exposing consumers to potential risks (Dugonjić and Bećirović, 2023). Partial supervision of imported halal raw materials, semi-finished products and finished products is carried out if they are used in further processing in the production or the provision of services that have been certified by an accredited halal certification body.

5. Possible solutions

Efforts to address the challenges in the EU halal market have been met with both progress and obstacles. Two notable attempts to overcome these challenges include:

1. **European Association of Halal Certifiers (AHC-EUROPE)**: Founded in Brussels on March 9, 2010, AHC-EUROPE emerged as an Islamic, independent, non-profit, and non-governmental institution. Comprising ten halal certification bodies from Europe, its primary objective was to foster cooperation and facilitate activities among member organizations. AHC-EUROPE aimed to serve as the reference institution for halal affairs in Europe to third parties, thereby promoting standardization and credibility in the halal certification process (GIMDES, 2010).

2. **European Committee for Standardization (CEN) Working Group**: In 2010, CEN established a Working Group tasked with analyzing the feasibility of implementing a European Standard to regulate the requirements for halal food. The group consisted of experts from EU countries, Turkey, and Bosnia and Herzegovina. However, despite several years of deliberation, the working group was dissolved due to significant opposition from Muslim communities in Europe (Kayadibi, 2014). These communities expressed concerns that halal matters primarily fall under religious jurisdiction and should be governed by Muslim religious authorities. The French Muslim community, one of the largest in Europe, explicitly rejected the proposal, asserting that religious questions, decisions, and accreditation pertaining to halal certification are the exclusive domain of competent Muslim authorities and institutions. They emphasized that non-Muslim organizations should not own standards for halal procedures used by the Muslim community (HalalFocus, 2015).

These attempts highlight the complexities surrounding the regulation and standardization of halal certification in the EU. While there have been initiatives to address these challenges, resistance from Muslim communities underscores the importance of respecting religious authority and ensuring that any regulatory framework aligns with Islamic principles and practices. Moving forward, collaboration and dialogue between regulatory bodies, certification organizations, and Muslim communities will be essential to establish effective and widely accepted standards for halal certification in the EU.

6. The foundation of European Halal Accreditation Agency?

The establishment of a Halal Accreditation Agency in non-OIC is viewed as imperative from the perspective of halal certification bodies. Over 65% of them advocate for the need to accredit or recognize halal certificates from Organization of Islamic Cooperation (OIC) countries for products sold in non-OIC countries. Additionally, half of these bodies believe that a halal accreditation agency should be established in countries outside the OIC, such as the USA or the EU (Dugonjić and Mešić, 2023).

The Turkish government established the Halal Accreditation Agency (HAK) on November 18, 2017. HAK, the sole legal entity authorized to provide halal accreditation services, operates in accordance with OIC/SMIIC 3:2019 standards. It accredits halal certification bodies that meet the requirements outlined in OIC/SMIIC 2:2019. Today halal accreditation by the HAK is obligatory for halal certification bodies for products and services which will be placed on the Turkish market including those imported. To date, HAK has issued 45 accreditation certificates for Halal Conformity Bodies (HCB) in compliance with OIC/SMIIC 2:2019 requirements (HAK, 2024).

The main requirements of OIC/SMIIC 3:2019 stipulate that:

1. The halal accreditation body (HAB) must be an Islamic entity legally registered.
2. Personnel of HAB must adhere to Islamic principles in their actions.
3. HAB must ensure that all personnel involved in halal conformity assessments and accreditation activities are Muslims with technical competency and ethical commitment to Islamic values.
4. Accreditation criteria for halal conformity assessment bodies must align with relevant normative documents, such as OIC/SMIIC standards and guidelines (SMIIC, 2019).

Given the challenges faced by halal certification bodies in the EU market and their expressed need for accreditation, establishing a European Halal Accreditation Agency following these standard requirements is deemed necessary. Countries such as Croatia and Bosnia and Herzegovina are prime candidates for hosting the headquarters of such an institution. Croatia, an EU member, recognized Islam in 1916 and has a history of collaboration with its Islamic community, as evidenced by agreements signed in 2002 (Dugonjić, 2019). Bosnia and Herzegovina has a longstanding tradition of Islamic authority and holds observer status in the OIC, with EU candidate status. Both countries have developed national halal standards and possess decades of expertise in halal standardization and certification, making them well-suited to host the European Halal Accreditation Agency.

7. Conclusion

In recent years, significant progress has been made in the realm of halal accreditation. The publication of OIC/SMIIC 3:2019_Conformity Assessment - Requirements for Halal Accreditation Bodies Accrediting Halal Conformity Assessment Bodies by SMIIC and the establishment of the Islamic Forum for Halal Accreditation Bodies (IFHAB) by the Organization of Islamic Cooperation (OIC) are notable developments. The creation of IFHAB holds promise for further positive changes in the halal accreditation landscape. With numerous halal certification bodies having obtained at least two accreditations and recognition of certificates, particularly those from the EU, IFHAB's role in

harmonizing and standardizing these processes will be crucial. Given the challenges faced by halal certification bodies in the EU, including the growing Muslim population, the region's significance as a halal product producer and exporter, self-declared halal products, and the need for effective supervision of imported halal goods, establishing a European Halal Accreditation Agency appears to be a viable solution. Such an agency, adhering to the requirements of OIC/SMIIC 3:2019, and with membership in IFHAB, would ensure consistency, credibility, and adherence to Islamic principles in the halal certification process within the EU.

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TREBA LI NAM EVROPSKA AGENCIJA ZA HALAL AKREDITACIJU?

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SAŽETAK

U posljednjoj deceniji svjedoci smo razvoja halal standarda za hranu, tijela koja pružaju usluge halal certificiranja i tijela koja pružaju usluge halal akreditacije. Najvažnija institucija koja objavljuje halal standarde je Institut za standarde i mjeriteljstvo za islamske zemlje (SMIIC), a u pogledu halal akreditacije objavila je OIC/SMIIC 2:2019 Procjena usklađenosti – Zahtjevi za tijela koja pružaju usluge halal certificiranja i OIC/SMIIC 3: 2019 Ocjena usaglašenosti - Zahtjevi za halal akreditacijska tijela koja akredituju halal certifikacijska tijela. Zemlje poput UAE i Turske implementirale su ove standarde kao svoje nacionalne standarde i počele su izdavati halal akreditaciju za halal certifikacijska tijela. Ono što nedostaje je da će halal certifikacijska tijela ako žele da se akredituju u obje navedene zemlje izabrat će akreditaciju u svakoj zemlji.

Ogroman korak napravila je Organizacija islamske saradnje (OIC) osnivanjem Islamskog foruma za halal akreditacijska tijela (IFHAB) sa ciljem da halal akreditacija za halal certifikacijsko tijelo u jednoj od zemalja članica OIC-a, bude međusobno priznata između zemlja članica.

Međutim, glavni izazov na halal tržištu EU je nedostatak jasnih regulatornih okvira za halal certifikaciju, standardizaciju i akreditaciju, čak i najvažnija tijela za halal certificiranje imaju halal akreditaciju prema gore navedenim standardima pitanja koja ostaju:

1. samoproglašenje halala za hranu i usluge,
2. halal certifikat bez akreditacije za tržište EU,
3. nadzor halal hrane koja je uvezena iz zemalja OIC-a u EU.

Ovaj rad ima za cilj da analizira potrebu za osnivanjem Evropske agencije za halal akreditaciju koristeći sekundarne izvore i prethodna istraživanja autora.

Ključne riječi: *Halal certificiranje, halal akreditacija, EU halal tržište*

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HALAL TOURISM AS AN OPPORTUNITY FOR DIFFERENTIATION AND DEVELOPMENT OF THE COMPETITIVENESS OF A DESTINATION ON THE EXAMPLE OF SARAJEVO CANTON

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Professional paper

ABSTRACT

With the halal market being one of the fastest-growing markets today, halal tourism has become globally recognized as an excellent opportunity to enhance the competitiveness of tourist destinations. There is a growing interest among Muslim travelers and even markets which aren't typically Muslim are turning to halal certification, adapting their offerings to halal standards.

Although halal tourism is often identified exclusively with the consumption of halal food, it is a much broader spectrum of elements that make a certain market a halal friendly destination; above all, the existence of facilities for prayer and offering accommodation in line with Islamic regulations. According to the Global Muslim Index report for the year 2023, Bosnia and Herzegovina has emerged as one of the most visited halal tourist destinations in Europe.

The global tourism market has undergone significant changes, largely influenced by the COVID-19 pandemic. Mass tourism has been replaced by individual experiences, with a focus on meeting the specific needs of tourists and searching for new forms of tourism as the basis for differentiation and sustainable development. In such conditions, halal tourism emerges as an outstanding opportunity for destination competitiveness, and Sarajevo possesses the natural and social potential for the expansion of this tourist niche. With Islam as the dominant religion, numerous mosques, halal food and accommodation facilities compliant with halal standards, Sarajevo represents a kind of natural halal-friendly destination. Furthermore, one-third of the total tourist traffic in the Sarajevo Canton comes from the Gulf countries, which are the largest consumers in halal tourism.

However, halal tourism is not just an economic opportunity; it successfully changes the narrative in accepting other cultures and religions. By leveraging the full potential of halal tourism, Sarajevo can become an attractive year-round destination and further strengthen its reputation as a European symbol of multiculturalism and tolerance.

Keywords: *halal tourism, tourist niche, halal friendly destination, differentiation, competitiveness*

Methodological approach and goal of the paper work

This paper used data in the form of published scientific articles, books, media reports, conference papers and other written forms on all important aspects of halal tourism. The work is also the result of market analysis and experience in tourism.

Therefore, the primary goal of this paper is to explore the potential of halal tourism as a means to differentiate and enhance the competitiveness of Sarajevo Canton as a tourist destination. This study aims to analyze the key elements that make Sarajevo a halal-friendly destination, assess the opportunities for development, and discuss the social and economic benefits of promoting halal tourism in the region.

Introduction

In the narrowest sense, the definition of halal includes everything that is permitted in accordance with Islamic principles, that is, what is not prohibited. With the halal market, which represents one of the most dynamic and fastest growing markets today, and with the increase in the population consuming halal products and services, halal tourism as a relatively new tourist niche is gaining more and more importance. At the same time, the interest of Muslim travelers, who have considerable purchasing power, for destinations that can satisfy their specific needs, respecting Islamic principles and values, is growing. Halal tourism is globally recognized as an extraordinary opportunity for opening new business opportunities and improving the competitiveness of tourist destinations. The public and private tourism sector in Sarajevo Canton has identified halal tourism as an important specific form of tourism that forms an integral part of the tourist offer and tourist product of this destination. Taking into account the data according to the last official population census in the Canton of Sarajevo, according to which more than 80% of the inhabitants of this canton are of the Islamic faith, it is clear that this is a tourism market that has natural conditions for the development of this type of tourism and is relatively familiar and accessible to Muslim travelers. However, even markets that are not traditionally Muslim are increasingly turning to halal certification, adapting offerings to halal standards, and exploring ways to attract new guests and differentiate themselves from the competition. For example, research conducted among producers holding halal certificates in neighboring Croatia showed that halal certification leads to an increase in product exports and has an impact on increasing income and profits, with the tourism sector experiencing the most significant benefits.

Characteristics of halal friendly tourist destinations

Halal tourism in practice implies compliance with all steps in the chain of preparation and implementation of tourist arrangements in accordance with halal requirements. Although halal tourism is often identified exclusively with the consumption of halal food, which is undeniably a very important part of the tourist offer, given that gastronomy is an indispensable and central part of the tourist experience, it is still a much broader spectrum of elements that make a certain market a halal friendly destination. A halal friendly tourist destination is defined as a place that meets the needs of Muslim travelers by providing services and facilities that are in line with Islamic principles and values, i.e. they can offer the possibility of consuming halal food and drinks, have a sufficient number of mosques or facilities for prayer and offer accommodation in accordance with Islamic regulations. The added value that halal friendly destinations develop and offer refers to specific programs and contents that are adapted to the needs and interests of Muslim tourists. This may include tourist tours accompanied by certified guides, tourist visits to Islamic objects of historical significance, cultural, entertainment and musical programs with Islamic motifs, additional luxury facilities such as swimming pools, hammams and massages adapted to the specific needs of consumers of these services, and so forth.

The World Tourism Organization emphasizes sustainability as an imperative for the growth of the tourism sector, and halal tourism is fundamentally based on Islamic regulations that fully advocate and support the concept of sustainable development.

According to the Global Muslim Index report for the year 2023, Bosnia and Herzegovina stands out as one of the most visited halal tourist destinations in Europe, taking the fourth place, and the halal industry of Bosnia and Herzegovina is the leader in Southeastern Europe. Through the development strategy of the Sarajevo Canton, sectoral strategy, as well as individual promotional activities of the public and private tourism sectors, the Sarajevo Canton increasingly recognizes halal tourism as one of the specific forms of tourism that can provide the greatest opportunities for destination development, differentiation from the competition, enriching the tourist offer, and creating a unique experience as the prevailing global trend in tourism.

Opportunities and development potential of halal tourism in Sarajevo Canton

More than a third of Bosnia and Herzegovina's tourist traffic takes place in the Sarajevo Canton. An interesting cultural and historical heritage, the proximity of the Olympic mountains, numerous green oases, a rich gastronomic offer, vibrant festival scene and the longest siege in modern history are just some of the reasons why tourists from all over the world choose to visit Sarajevo. However, the global tourism market has undergone major changes, mostly under the influence of the coronavirus pandemic, which has completely changed the travel habits and demands of tourists. Mass tourism has been replaced by individual experiences, with a focus on understanding and meeting specific tourist needs, personalized approaches, inclusivity, and the search for new specific forms of tourism that will be the foundation for differentiation as a key for sustainable development. In such conditions, halal tourism stands out as an extraordinary opportunity for the development of the destination's competitiveness, and Sarajevo Canton has natural and social potential for the expansion of this tourist niche.

With Islam as the dominant religion, Sarajevo Canton is a kind of natural halal friendly destination. Development possibilities and prerequisites for strengthening halal tourism stand out through:

Cultural and historic heritage. With a history and tradition of Islamic culture spanning over five centuries, the Sarajevo Canton is an exceptionally rich tourist destination, with particular value attributed to its interweaving with other religions and cultural influences.

The number of Islamic religious buildings. In Sarajevo Canton, there are more than 160 active mosques (jamaats) in all urban and suburban municipalities, which ensures maximum availability of prayer facilities for Muslim travelers. The Sarajevo International Airport also has space for performing religious duties in accordance with Islamic regulations.

Availability of halal products and services. Considering the pronounced majority of the Muslim population, the availability of halal products and services is at the highest level, including halal food, cosmetics, pharmaceutical products, health services, tourist arrangements, etc.

Halal food offer and accommodation facilities in accordance with halal standards. The basic elements of the tourist experience are accommodation and gastronomy. Traditionally, food in catering facilities in Sarajevo Canton is prepared in accordance with halal standards, and the accommodation facilities are adapted to the needs of Muslim travelers. However, the insufficient number of halal certified establishments must be mentioned as a key drawback. Increasing awareness of the importance of halal certification as a guarantee of quality and recognition is the surest way to increase tourism and hospitality traffic from the halal market.

Traditional cultural and religious events. Events such as the Ramadan festival „Visit Sarajevo – Feel the Spirit of Ramadan“ implemented by the Majlis of the Islamic Community of Sarajevo and the Tourism Association of Sarajevo Canton,

which combine a religious, touristic, cultural and entertainment character, aim to attract tourists and offer additional content for a fulfilling and extended stay. Although it cannot be classified as a typical prerequisite for the development of halal tourist destinations, the additional advantage of Canton Sarajevo are numerous green oases, natural beauty and a rich outdoor tourist offer, which is a significant factor that attracts tourists, especially from the Gulf countries.

As special opportunities in the development of halal tourism, congress tourism and the MICE industry, i.e. business events with the halal label, which are on the rise with the increase and strengthening of the halal market, should be considered. Another interesting sub-sector of halal tourism can be solo female travelers who recognize Sarajevo as a safe and friendly destination. Halal tourism and standards can be easily and successfully combined with all other specific forms of tourism, such as gastro tourism, outdoor and adventure tourism, health tourism, etc. The most important feature of halal tourism is that it does not have to be a limiting factor in any case; quite the opposite – applying the halal standard only opens up additional benefits and opportunities for all participants in the supply chain.

Challenges for the development of halal tourism in Sarajevo Canton

The development of halal tourism may face several challenges and requires a coordinated approach between governments and the private sector to provide the best experience for halal tourists.

While many destinations face problems such as insufficient infrastructure, lack of standardization, mistrust of halal certificates or cultural differences that can be a source of problems and a challenge that is very difficult to overcome, Sarajevo Canton does not have these difficulties. However, it is important to identify the specific challenges this destination faces in order to overcome or mitigate them.

Prejudices and stereotypes. Halal tourism, even in a Muslim-majority society, sometimes can be misunderstood or stereotypically represented. General ignorance about the concepts and practices of halal tourism and linking halal tourism with restrictions can lead to a poor experience for tourists.

Insufficient number of businesses in tourism that have a halal certificate. This is a situation where an advantage threatens to become a disadvantage. Given that halal as a principle is literally considered a lifestyle in Sarajevo Canton, many carriers of tourist infrastructure and offers do not possess a halal certificate, even though they have all the necessary conditions and apply halal standards in their business. Awareness of the importance of halal certification in terms of confirmation and guarantee of quality is unfortunately at a low level.

Lack of staff training. It is necessary to educate tourism workers about the specific needs of halal tourists, including cultural sensitivity and specific services required.

Economic issues. Implementing halal standards can be expensive, which can be a financial challenge for smaller businesses. Service providers may be concerned about the uncertainty of return on investment in halal tourism.

Insufficient promotion. Halal tourism offer of Sarajevo Canton is not sufficiently promoted in the global market. Promotion on the markets of the Gulf countries, Malaysia, Singapore and Turkey through tourism fairs and roadshow campaigns has been implemented for several years thanks to the Tourism Association of Sarajevo Canton, which gathers co-exhibitors and key stakeholders, but it is necessary to systematically develop a long-term and short-term strategy for adequate and more intensive promotion through offline and online promotional channels.

Social and economic benefits of halal tourism

The halal market has seen continuous growth in supply and demand year after year, and the current value is estimated at 3 trillion US dollars, with almost two billion users. Even in the conditions of the pandemic and the global economic crisis, this market recorded an increase.

It is estimated that hundreds of millions of Muslim tourists travel annually and are generally considered good consumers. The most important emitting halal markets are the Gulf countries, Turkey, Indonesia, Iran, and countries from Southeast Asia and Western Europe.

The advantage that Sarajevo should take advantage of is the statistical data that a third of the total tourist traffic generated in the Canton of Sarajevo comes from the markets of the Gulf countries, which are the largest consumers in halal tourism, and approximately 15% of tourists visiting the Sarajevo Canton come from another significant global halal market – Turkey. When these figures are combined with the respectable markets of Malaysia and Western European countries, halal travelers from Great Britain, but also the Islamic diaspora that visits the Canton of Sarajevo and whose annual current transfers are measured in billions of convertible marks and contribute to the stability of the domestic economy, it becomes evident that investing in halal tourism in the Sarajevo Canton can open up numerous opportunities to increase tourist traffic and tourism revenue.

The economic aspects of halal tourism, in addition to the increase in income from tourism, are also reflected in the increase in employment and opportunities for the active involvement of the local population, local suppliers and small craftsmen in the creation of a complete offer that includes different profiles of products and services. It is estimated that products and services classified as halal can have up to 40% higher prices than products and services that do not meet halal standards, and consumers are found not only in individuals who practice halal lifestyle, but also in general among all lovers of a healthy lifestyle. Consumers are increasingly demanding products that are high-quality, natural and certified, which further supports the demand for halal products of all kinds. However, halal tourism is not only an economic and social opportunity, but also a means of promoting religious tolerance because it is one of the most representative tourist niches that successfully changes the narrative in accepting other cultures and religions. This type of tourism provides visitors with the opportunity to learn about new cultures and customs, as well as to explore traditions, architecture, gastronomy, art and other cultural aspects of the destination, which ultimately contributes to the preservation and promotion of local heritage. Halal tourism fully supports the concept of sustainable tourism and can be a significant factor for the sustainable development of a tourist destination.

Conclusion

Although halal-friendly destinations primarily focus on Muslim tourists, religious tourism and getting to know different religions and customs are of interest to tourists of all religious affiliations. The development of halal tourism contributes to the diversification of the destination's tourist offer, which is essential for reducing seasonality and dependence on certain tourist markets. This specific form of tourism attracts investments in tourism infrastructure, which accelerates economic development and creates a more favorable business environment. Halal tourism brings significant social and economic benefits to destinations and local communities, promoting inclusive tourism that respects different cultures, religions and lifestyles and ensuring sustainable tourism growth.

This study demonstrates that halal tourism offers substantial opportunities for Sarajevo Canton to enhance its competitiveness as a tourist destination. By focusing on Muslim tourists while appealing to a broader audience interested in religious and cultural tourism, Sarajevo Canton can diversify its tourist offerings, reduce seasonality, and attract significant investments in tourism infrastructure. The findings highlight that the region's rich cultural heritage, combined with its existing halal-friendly facilities, positions it favorably in the halal tourism market.

To fully capitalize on this potential, it is crucial to increase awareness of the importance of halal certification and develop a comprehensive promotional strategy. This strategy should provide potential tourists with detailed information about the halal tourism offer available in Sarajevo Canton.

In conclusion, leveraging the full potential of halal tourism can make Sarajevo Canton an attractive year-round destination, fostering economic growth, cultural understanding, and reinforcing its reputation as a European symbol of multiculturalism and tolerance. Future efforts should focus on addressing the current gaps in halal certification and enhancing the overall tourist experience to meet the specific needs of halal travelers.

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HALAL TURIZAM KAO PRILIKA ZA DIFERENCIJACIJU I RAZVOJ KONKURENTNOSTI DESTINACIJE NA PRIMJERU SARAJEVSKOG KANTONA

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Stručni rad

SAŽETAK

S obzirom da je halal tržište jedno od najbrže rastućih tržišta danas, halal turizam je postao globalno prepoznat kao odlična prilika za povećanje konkurentnosti turističkih destinacija. Postoji rastući interes među putnicima muslimanima, pa čak i tržišta koja nisu tipično muslimanska okreću se halal certifikaciji, prilagođavajući svoju ponudu halal standardima.

Iako se halal turizam često poistovjećuje isključivo s konzumacijom halal hrane, radi se o mnogo širem spektru elemenata koji određeno tržište čine halal friendly destinacijom; prije svega postojanje objekata za molitvu i nuđenje smještaja u skladu sa islamskim propisima. Prema izvještaju Globalnog muslimanskog indeksa za 2023. godinu, Bosna i Hercegovina se nametnula kao jedna od najposjećenijih halal turističkih destinacija u Evropi.

Globalno turističko tržište pretrpjelo je značajne promjene, u velikoj mjeri pod utjecajem pandemije COVID-19. Masovni turizam zamijenjen je individualnim iskustvima, s fokusom na zadovoljavanje specifičnih potreba turista i traženje novih oblika turizma kao osnove za diferencijaciju i održivi razvoj. U takvim uslovima, halal turizam se pojavljuje kao izuzetna prilika za konkurentnost destinacije, a Sarajevo posjeduje prirodni i društveni potencijal za širenje ove turističke niše. Uz islam kao dominantnu religiju, brojne džamije, halal hranu i smještajne kapacitete usklađene sa halal standardima, Sarajevo predstavlja svojevrsnu prirodnu halal-friendly destinaciju. Nadalje, jedna trećina ukupnog turističkog prometa u Kantonu Sarajevo dolazi iz zemalja Zaljeva, koje su najveći potrošači u halal turizmu.

Međutim, halal turizam nije samo ekonomska prilika; uspješno mijenja narativ u prihvatanju drugih kultura i religija. Iskorištavanjem punog potencijala halal turizma, Sarajevo može postati atraktivna cjelogodišnja destinacija i dodatno ojačati svoju reputaciju evropskog simbola multikulturalnosti i tolerancije.

Ključne riječi: *halal turizam, turistička niša, halal friendly destinacija, diferencijacija, konkurentnost*

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IMPACT OF MIGRATION OF SUBSTANCES FROM PACKAGING MATERIALS ON THE HALAL STATUS OF FOOD

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ABSTRACT

Packaging plays an important role in the containment, protection, and preservation of products throughout the supply chain activities. For a halal-certified product, the packaging is expected to protect and preserve its halal integrity until the product reaches the consumer. However, cases of migration of nonhalal substances originating from the packaging materials were reported. The issue has called for halal certification of the packaging material especially the ones which are in direct contact with the halal product. Such interaction between food and packaging materials is considered to be an interchange among food, packaging, and the environment and can impact food quality, safety, and/or halal status of food. The main goal of food packaging is to protect food from external environmental factors, but food–packaging interactions also can compromise the quality and/or safety of foods and halal status of the food.
However, the mass transfer of additives from packaging to the foods is undesirable and can alter the food's flavor. Other undesired phenomena include removal of some desirable flavors from the food to the packaging and the uptake or release of moisture by permeation. An interesting possibility is that food quality and safety could be enhanced via such package-to-food interactions.

Keywords: *Halal, Migration, Packaging material, Halal Certification, Islamic Dietary Laws*

Introduction

Halal food is closely related to halal certification. Foods with Halal certification are called Halal foods. The relationship between halal certification and food can be easily found in the literature. Halal certification ensures that a food is permitted or "allowed" for Muslims. Certification also provides distributors with the opportunity to establish operational and product differentiation strategies that focus on other attributes besides pricing, such as: providing convenience, variety, consistency, quality, and security.The construction of what is included within the halal parameters of the two main sources of sharia, the Quran and the Sunnah, and the issuance of fatwas by national religious authorities, depend on the process of halal certification

Halal, meaning permissible in Arabic, refers to products and practices that are compliant with Islamic principles. The concept of Halal Control

Points (HCPs) is crucial in certifying various industries to ensure their products are Halal and meet the dietary requirements of Muslims. This research focuses on identifying and understanding HCPs in the food industry,

Migration

The most common food packaging materials are different types of plastic polymers, including bio-based and biodegradable plastics, paper and board, metal, glass, and various multilayer materials. The packaging materials are used in combination with each other and with other materials, such as printing inks, adhesives, and coatings. Besides its many useful properties, food packaging is a well-known source of chemicals that can be transferred from the packaging into food and beverages. This process is called chemical migration, and it leads to low levels of chemical mixtures regularly becoming part of everybody's diet.

Packaging material used in food industry

In the food industry, when it comes to halal status, the greatest focus is placed on the food, the choice of ingredients, the method of preparation, but very little emphasis is placed on the packaging material and the possibility of changing the halal status of the food according to the material in which it is packaged food.

Materials and methods

Research Objects

The research consists in determining the composition of primary packaging materials and the power of migration of haram ingredients in food

Primary packaging- Glass

Glass has been around for centuries, used for everything from jewelry to coffee tables and windows to fine art. It is common to see a variety of glass bottle shapes in grocery stores, as glass bottles are deemed food-safe containers for a number of products, including condiments, pickles, and sodas. As glass does not change the taste of the foods it contains, it's the ideal choice for foods and beverages. Glass is virtually inert and impermeable, making it the most stable of all packaging materials and it is generally heat-resistant and, most importantly, recyclable. Its versatility continues to make it a widely-used product in every facet of life.

To begin the glass bottle making process, the silica sand must be mixed with several other materials. Soda ash (sodium carbonate) is added in a smaller percentage to decrease the melting point of the sand. This allows the sand to melt faster in the furnace, saving energy along the way. Adding only soda ash to the sand would eventually result in the production of a bottle capable of dissolving in water. To avoid such a result, limestone (calcium carbonate) must be added. The resulting glass type is then referred to as soda-lime glass, which accounts for approximately 90% of the world's glass production.

Food-Safe Glass Bottles

In the United States, the Food and Drug Administration (FDA) oversees food safety regulations. The FDA is responsible for determining which materials are considered food safe, including the processes used in glass bottle manufacturing and the creation of food-safe glass bottles and jars. As part of the FDA process for qualifying packaging options for food safety, the agency considers the glass and plastic containers used in food packaging to be indirect food additives. This means the containers used to hold food and beverages make contact with the products as part of the production process. The plastic and glass used in packaging isn't a direct additive to the products but nonetheless must be validates as safe for food applications.

The FDA has previously advised that soda lime glass bottles and jars are not "food additives". Soda-Lime glass is classified as Type I, Type II, and Type III which are all considered to be food safe, or in the terms of the FDA, GRAS (generally regarded as safe). For this reason, soda- lime

bottles are very often chosen as the packaging of choice for most food and beverage products.

Type I Borosilicate Glass
A Type I glass container contains silica, boric oxide, sodium oxide, and aluminum oxide. It is suitable for packing alkali materials and acids and is considered food-grade safe.

Type II Treated Soda Lime Glass
Type II glass container is suitable for liquids and acids. It is similar in composition to Type III glass and is easier to mold than Type I glass and is food-grade safe.

Type III Soda Lime Glass
Type III glass is untreated soda lime glass offering average chemical resistance. It is made up of silica and various oxides, including sodium, calcium, aluminum, magnesium, and potassium. Type III is the most common glass type in use and is compatible with most items such as: food, beverages, and common chemicals - and, it is food-grade safe.

Migration from packaging material to food

The migration phenomenon in packaged foods may happen in two directions simultaneously, i.e., from packaging material to the food product and vice versa (Mousavi et al., 1998). In the former case, the molecularly diffused low-molecular weight substances such as additives and oligomers from the packaging films are transferred into the foods (Helmroth et al., 2020).

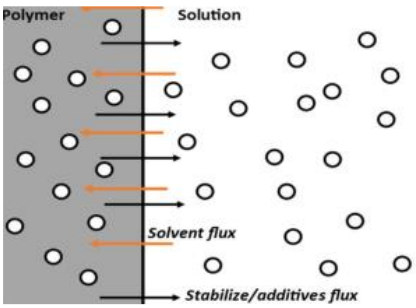

Figure 1. The polymer packaging and food interface suggesting chemical migration.

In the latter scenario, the mass transfer of food color, aroma, flavor, and nutrients happens from the food product to the packaging and results in a strong impact on the organoleptic properties of foods (Lee et al., 2008).

Types of food packaging migrating compounds
From printing inks

The packaging, besides providing containment for the foods, also delivers information about the brand and composition and provides nutritional labelling for the foods. High-performance plastic packaging materials are very effective for shelf stability of the product until expiry. Generally, the single layer of material used in packaging the food products also has printed inks to disseminate the product description to consumers. A food stored in such packaging could increase the probability of transfer of printing dyes or inks to the food and thus may pose a quality and safety challenge. Printable ultraviolet (UV)-curable inks and varnishes are commonly used in packaging and normally comprise three components: a monomer, an initiator, and a pigment. For application, the ink is exposed to a UV source where the photoinitiator is converted into a free radical that ultimately reacts with the added monomers and starts polymerization (Castle et al., 1997, Robertson, 2006, Samonsek and Puype, 2013). During polymerization, the developed polymers bind the base polymeric packaging irreversibly and entrap the pigments resulting in a fast and good-quality printed surface. Some other printing inks are composed of pigmented resins and an organic carrier or polar solvent. This type of ink requires adequate drying if solvent removal is necessary, and print quality is highly dependent on numerous factors. In the case of UV-cured inks, the unbalanced formulation of the monomers and photoinitiators and incorrect functioning of the UV source may result in excessive residuals of monomers or photoinitiators. Thus, a potential migration of these substances into a food matrix would alter the organoleptic properties of food and compromise the safety of the food. Additionally, the interaction of the migrating species with the food would initiate taints and possibly result in loss of quality and nutritional value (Johns et al., 2000, Boon, 2008, Bradley et al., 2013).

Migration of benzophenone, a frequently used odorless photoinitiator, has been reported to generate alkyl benzoates, which contribute to undesirable flavors. Studies have reported the presence of printing inks in snacks and confectionary products well above the minimal detectable limits. Similarly, plasticizers, commonly used in packaging materials and in printing inks to provide functions such as flexibility, wrinkle resistance, and adhesion, are capable of contaminating foods by migrating from the packaging films. The presence of phthalates and other compounds such as tris(2-ethylhexyl) trimellitate, sulphonamides, and N-ethyl-toluene and N-methyl-toluene has been detected in printing inks. However, the chance of mass transfer of printing ink is relatively lower than that of the plasticizers used in the fabrication of packaging materials during direct contact with foods (Rasff, 2005, Boon, 2008, Bradley et al., 2013).

From adhesives

Adhesives are the compounds that are used to seal the packaging and they can also migrate to the foods during packaging or storage. The adhesives commonly used in the packaging industry are hot-melt, cold-seal, pressure-sensitive polyurethanes and acrylics that are water- or solvent- based or solvent-free. The selection of adhesives must be based on the type of packaging and characteristics of the food product. For example, the use of a hot-melt adhesive is inappropriate for wrapping bars of milk chocolate. Also, special requirements apply in cases where aromatic volatiles are directly incorporated in cold seals to augment the food-product perception at the time of opening (Athenstädt et al., 2012, Sella et al., 2013). From a previous survey by adhesive manufacturers, a listing of more than 360 substances was compiled to indicate potential chemical migrants from adhesives into foods.A subsequent study focused on the chemical composition and level of migration of polyurethane-based adhesives. The migrating residuals (e.g., polyether, polyols, and cyclic reaction products derived from polyester polyols) were identified at concentrations of 10–100 μgdm−2 (Sella et al., 2013, Hoppe et al., 2016). The migrants from the inks of a printed packaging surface also can easily transfer to the layer of adhesives, especially when the packaging is stacked, and thus could ultimately migrate to the food matrix during the process of packaging. However, in the case of multilayer packaging systems such as laminates, the chances of potential contact migration of migrants are increased significantly. The multilayer laminates are complex packaging materials that are manufactured by layering of different polymeric with non-polymeric materials (e.g., metals) to achieve particular packaging characteristics. The existence of diverse components along with adhesives could greatly increase the likelihood of health problems while also making the identification and detection processes more difficult and complex.

Plastic packaging

Plasticizers

Most plasticizers are the esters of phthalic (phthalates) and adipic acids. Dioctyl phthalate, di-2-ethylhexyl phthalate and di-2-ethylhexyl adipate are systematically applied during the preparation of packaging material. The phthalates are cast off in sealing gaskets and cap-sealing resins for bottled food, polyvinylchloride (PVC) films, and some plastic packaging. Phthalates once used as plasticizers in polymeric packaging films are characterized by low molecular weight, thus facilitating the package-to-food migration.

Thermal stabilizers

Thermal stabilizers are commonly incorporated in plastic materials, including PVC and polystyrene (PS). Generally, epoxidized seed and vegetable oils (e.g., soybean oil–esterified soybean oil) is commonly used in a wide range of food-contact plastic-polymer films as heat stabilizers, lubricants, and plasticizers (Lau and Wong, 2000). From studies of the impact of the degree of purity on toxicity, it was found that residual ethylene oxide is highly toxic.

Slip additives

Fatty acid-based amides are extensively used as additives in plastic packaging manufactured from polyolefins, PS, and PVC. Slip additives, which are directly incorporated into the plastic formulations, cause the emergence of surface bloom. These compounds are used to impart specific characteristics to the products. For example, they provide lubricating properties to the packaging materials to avoid sticking or conglomeration and also to reduce static charges (Cooper and Tice, 1995, Arvanitoyannis and Bosnea, 2004).

Light stabilizers

These chemicals are used in plastic packaging materials (polyolefins) to enhance endurance for long-term applications. Light stabilizers are used in many applications to improve long-term weathering properties of plastic polymers such as polyolefins.

Antioxidants

When polymers are exposed to UV light and air, they could be degraded significantly owing to the oxidation reactions. Antioxidants can be applied to decrease the degree of oxidation and enhance stabilization of the polymers. Tinuvin P, Tinuvin 776 DF, Tinuvin 326, Tinuvin 234, Irganox168, Irganox 1010, Irganox 1330, and Irganox P-EPQ are the commonly used chemical antioxidants in plastic packaging materialsAlso, vitamins such as A, C, and E and derivatives such as tocopherols, tocotrienols, and carotenoids can be added. Similarly, some metal ions (e.g., selenium) are crucial for the activity of antioxidant enzymes, and other phytochemicals, such as CoQ10, glutathione, and lipoic acid, are also considered good in controlling the oxidation of packaging materials.

Solvents

Various solvents are used in the preparation of solutions or in dispersions of the printing inks used in plastic packaging. The solvents are mainly low-molecular-weight organic compounds such as ethers, esters, alcohols, and ketones. These solvents are mostly evaporated from printed plastic packaging but may also disperse by distillation, penetration, or direct contact. However, some residue of the base solvent may remain entrapped in the packaging materials and later get transferred to the food upon direct contact or after release into the packaging headspace. The amount of solvent transferring to the food from packaging material is highly dependent on the concentration and distribution of the solvent. Therefore, potential migration of residual solvent may pose a risk of changing the food organoleptic properties.

Monomers and oligomers

Many monomers and oligomeric building blocks connect to produce polymers by various chemical reactions. Styrene is among monomers that are widely applied to produce PS, which is used in packaging that is in direct contact with foods. PS is used mostly as containment for a range of dairy products (ice cream, cottage cheese, yogurt), fruit juice and other drinks, poultry and other meat, bakery products, and fresh produce . Leibman (1975) reported that a styrene monomer may degrade into its respective oxide, which is characterized as a severe mutagenic and if metabolized in body can produce hippuric acid that could be excreted from the body in urine. Styrene exposure could result in organ toxicity and irritation of the skin, eyes, and lungs with simultaneous suppression of the activity of the central nervous system.

Isocyanates

Isocyanates are commonly used to produce polyurethanes and are used in some adhesives for the preparation of food packaging. Also, aromatic amines, especially primary amines, are a subcategory of this class of compounds, and Miltz et al. (1997) reported their migration into foods from materials such as rubber, epoxy polymers, aromatic polyurethanes, and azo dyes. The toxic effects of isocyanates on human health have been extensively reviewed in other studies (Lau and Wong, 2000). The maximum level of isocyanates residues must be < 1.0 mg kg−1 in the final packaging material. However, only 12 isocyanates are approved for use in food packaging.

Vinyl chloride

Under normal temperature and pressure conditions, vinyl chloride is a colorless gas. It is compressed into liquid under high pressure and has been used in the preparation of polyvinyl chloride-based packaging material. Vinyl chloride can leach from PVC bottles and food packaging and may modify the food organoleptic properties and also may result in toxicity. Because it is highly toxic, maximum allowed levels in food packaging have been in place since the 1970s. Many organizations, including the U.S. Food and Drug Administration, have established limitations regarding the maximum vinyl chloride content in food-packaging films and bottles.

Polyethylene terephthalate oligomer

Polyethylene terephthalate (PET) oligomers are used mainly in manufacturing of trays and bottles for packaging of various types of food (including fresh produce) and drink (including mineral water, juice, beer, carbonated beverages, and milk). It is a thermoplastic polyester produced by a condensation reaction (esterification) of ethylene glycol in the presence of terephthalic acid or its derivative as dimethyl terephthalate. PET is easy to mold for producing trays and dishes of various desired shapes, and due to its temperature resistance (~220 °C), these containers can be used in heating or reheating of food. However, PET reportedly contains small amounts of low-molecular-weight oligomers (some dimers to pentamers). Additionally, the main volatile substance found in PET is acetaldehyde, which is of high significance owing to its effects on food odors, especially in cola-type beverages.

Metal packaging

Tin

Tin-based cans are used in containing foods and various carbonated and noncarbonated drinks. Tin traces transfer into the foods contained in tin cans with or without any lacquering. Foods with higher concentrations of tin (e.g., ~500 mg kg−1) reportedly can cause severe gastrointestinal ailments. According to clinical trials, found that the threshold for an acute effect from tin starts after consuming a dose >730 mg kg−1. A thin layer of tin can help protect corrosion of metal cans. Although usually no lacquering is done for tin, especially when oxygen scavenging is desired, a lacquer coating is otherwise preferable because an uncoated can may lead to various interactions between the tin and the food matrix (Oldring, 2007).

Lead

Despite its toxicity and although it is known to be a common contaminant in foods, lead is commonly used in metal food and beverage containers. Lead toxicity could damage the central nervous system and has negative impacts on various body organs in humans. Infants are especially prone to lead toxicity because of the greater retention of lead in their brains and bones. Even a subacute consumption of lead could result in mental retardation, convulsions, and encephalopathy in children (Skrzydlewska et al., 2003, Robertson, 2006).

Aluminum

Al is used in preparation of laminate or multilayer food packaging or directly design cups and trays. It is used mostly in alloy form with other metals (such as Cu, Zn, Si, Mn, Mg, and Fe) to design food packaging. Small concentrations of Al are found in various plants and animals (Taylor, 1964). Unlike so many other vital elements that take part in the metabolism of animals, Al is not essential for the functionality of enzymes or any other metabolic process. High intake and increasing levels of Al in tissues have been associated with many disorders (such as dialysis encephalopathy, osteodystrophy, and microcytic anemia). Therefore, elements other than Al could be present in foods upon corrosion of the cans used to contain the food.

Chromium

Electrolytic Cr coating is widely used as a thin layer in tin-based cans to make them more stable against oxidative damage and to strengthen

enamel adherence. Cr is characterized by relatively high toxicity and undesirable sensory properties. Also, in its hexavalent form (Cr(VI)), it could have a severe impact on living organisms owing to its having both carcinogenic and mutagenic properties (Skrzydlewska et al., 2003, Kim et al., 2008).

Paper packagng

Dioxins

These form a class comprising a large number of synthetic polychlorinated compounds that include but are not limited to polychlorinated dibenzofurans and dibenzo-dioxins. Dioxins are used in paper-based packaging for food applications. Dioxins are reported as highly toxic and mutagenic organic compounds. The isomer called 2,3,7,8-tetrachlorodibenzo-*para*-dioxin is the most toxic among all the dioxins.

Benzophenone

This organic compound is used in inks and lacquers as a photoinitiator and also is used as a wetting agent for dyes and pigments to improve their flowability. In general, 5%–10% of this compound is used once considered as photoinitiator in inks (Anderson and Castle, 2003). UV light is used to cure the printing inks for cardboard packaging thus online production process of finished packaging is relatively faster. However, because the benzophenones used in these inks may not get totally removed during this process, benzophenone could migrate to the inner sides of the cardboard components during stacking before forming the cardboard cartons or boxes. Also, the use of fiber recycled from cardboard may increase the probability of the presence and migration of benzophenones. The specific compound 4-methoxybenzophenone is also used but reportedly is carcinogenic and mutagenic.

Nitrosamines

Nitrosamines are commonly found in foods and beverages (Robertson, 2006). These amines are considered potential carcinogens and genotoxic. Nitrosamines are formed endogenously in the human body by reaction of amines with salivary nitrates or nitrites. Nitrosamines could also come from waxed cardboard and paper. These materials contain morpholine and N-nitrosomorpholine, which contaminate food after migration from a surface upon contact during storage and the processes involved in packaging.

Chlorophenols and chloroanisoles

Chlorophenols are organochlorides that have been industrially used for the production of biocides, fungicides, and herbicide intermediates . These compounds commonly transfer into food from packaging materials. Contamination of foods with these organochemicals results in the production of off-flavors and taints.

Additive derivatives and monomers

Other than the multiple above-mentioned types of possible food contamination, various derivatives of additives and monomers also could transfer to foods. In particular, direct contact between food and packaging material could result in migration of chemical substances and potentially contaminate the product. The environment also could contaminate the food if water and air quality are not properly monitored and thoroughly cleaned.

Benzene and other volatiles

For diverse food-contact plastics, organic components such as benzene or alkyl-benzene are typically produced at higher temperatures. For example, benzene is known to migrate into food from PET-, PVC-, and PS-based food packaging. Owing to its low molecular weight, it can easily diffuse through the package and contaminate foods. Therefore, the detection of benzene levels in plastic-based food packaging is necessary given its potential carcinogenicity.

Environmental contaminants

The surrounding environment could be a major source of food contamination if it is not hygienic. Numerous environmental contaminants, such as dust, microbes, insects, and naphthalene, can be transferred into foods and result in contamination.

This may occur through damaged or absorbent packaging material with subsequent migration to the foods. For example, concentration of naphthalene could rise significantly in the environment where naphthalene- based insect repellants are in use. Similarly, milk or milk-based drinks packaged in low-density polyethylene containers have shown increased concentration of naphthalene once stored in high-naphthalene environments.

Other contaminants

Besides the already-mentioned contaminants, there are various possible components that could migrate and contaminate foods. For instance, PVC-based food packaging contains the contaminant dioxin. Similarly, benzene, diphenyl thiourea (a heat-stabilizing agent), processing-aids additives, and diverse volatiles may migrate into packaged foods. Contamination of foods by diphenyl thiourea and its derivatives (e.g., aniline, diphenylurea, isothiocyanatobenzene) reportedly has been found in packaging materials (Lawson et al., 1996, Careri et al., 2002, Arvanitoyannis and Bosnea, 2004).

Conclusion

The migration of components from the packaging material can affect the taste of the food, the composition of the food, its safety and its halal status. For components that migrate from packaging materials that are relevant for food safety there is a clearly established regulation. Regarding the halal status of substances that can migrate, there is no clear picture. The construction of what is included within the halal parameters of the two main sources of sharia, the Quran and the Sunnah, and the issuance of fatwas by national religious authorities, depend on the process of halal certification. Also, there are components that may affect the halal status of food, but are not subject to food safety legislation. Regarding the methods for proving such ingredients, since there are no clear rules, there are no accredited methods available that would determine the presence or absence of a specific migrated substance.

Food is usually packaged in plastic, wood, glass or metal. Food safety standards allow the use of material that does not migrate or has minimal migration as primary packaging. Material that migrates very little or does not migrate is likely to contain ingredients of animal origin. In this way, he receives food that is safe for consumption, but the halal status of the food may be questioned. Also is very important to be noticed that chemical migration increases at higher temperatures. Heat (and microwave) foods in suitable inert containers.In general, migration levels increase over time. Limit migration by shortening the storage time of foods.Small packaging formats have a high surface-to-volume ratio enabling higher migration levels. Many chemicals migrate at higher levels in fatty and-or acidic foods than in aqueous foods. This shows that handling of food can have direct influence on migration and also on halal status of the food. With the introduction of halal standards, this risk can be reduced by checking the suppliers of packaging material and requiring them to be approved for use in food. But the question remains open about the possibility of migration of components that are not subject to food safety and can change the halal status of food. In the world of food safety, the effect of environmental pollution is always connected. With this challenge before them, scientists are discovering and working on new packaging materials that will be environmentally friendly. New materials may have an impact on the halal status of food, which leads to an increased need to control new materials that may migrate into food and their halal status. Additionally, for consideration, which is a challenge of the halal industry is of course the use of recycled packaging, about the composition of which very little is known.

However, whether recycling can be applied to keep the material in a closed cycle and produce new food packaging strongly depends on the material type. Properties such as stability, color, and smell can change during recycling. Additionally, the chemical safety can be compromised if the material allows carry over of

contaminants or tends to degrade in the process. Trends emerging in the field of packaging materials will have an impact on determining the halal status of food.

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UTICAJ MIGRACIJE SUPSTANCI IZ MATERIJALA ZA PAKOVANJE NA HALAL STATUS HRANE

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Stručni rad

SAŽETAK

Ambalaža igra važnu ulogu u zadržavanju, zaštiti i očuvanju proizvoda kroz aktivnosti lanca opskrbe. Za halal certificirani proizvod, od ambalaže se očekuje da štiti i čuva svoj halal integritet sve dok proizvod ne stigne do potrošača. Međutim, prijavljeni su slučajevi migracije nehalal supstanci koje potiču iz materijala za pakovanje. Problem je zahtijevao halal certifikaciju materijala za pakovanje, posebno onih koji su u direktnom kontaktu sa halal proizvodom. Takva interakcija između hrane i materijala za pakovanje smatra se razmjenom između hrane, ambalaže i okoliša i može utjecati na kvalitet hrane, sigurnost i/ili halal status hrane. Glavni cilj ambalaže hrane je zaštita hrane od vanjskih faktora okoline, ali interakcije između hrane i ambalaže također mogu ugroziti kvalitet i/ili sigurnost hrane i halal status hrane. Međutim, masovni prijenos aditiva iz ambalaže u hranu je nepoželjan i može promijeniti okus hrane. Druge neželjene pojave uključuju uklanjanje nekih poželjnih aroma iz hrane u ambalažu i upijanje ili oslobađanje vlage prodiranjem. Zanimljiva mogućnost je da bi se kvalitet i sigurnost hrane mogli poboljšati kroz takve interakcije između paketa i hrane.

Ključne riječi: *halal, migracija, materijal za pakovanje, halal certifikat, islamski zakon o ishrani*

JOURNAL
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THE APPLICATION OF HALAL STANDARD IN DOLAR COMPANY D.O.O. KALESIJA

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Professional paper

ABSTRACT

This study presents the implementation of the HALAL standard in the slaughtering process at Dolar Company d.o.o., ensuring compliance with BAS 1049:2023. The primary objective is to provide consumers with confidence that the meat products align with their religious beliefs and practices. The implementation covers the entire process from ingredient sourcing to storage and transportation, preventing contamination with non-Halal substances. Special attention is given to defining critical control points in the feed for livestock, which could be a source of contamination. The paper highlights the applicability of legal documentation in meeting HALAL standard demands. The results demonstrate effective compliance with the standards, ensuring the production of Halal meat.

Keywords: *HALAL standard, meat industry, haram*

Introduction

The goal of this paper is to present the implementation process of the HALAL standard in the slaughtering of large livestock at Dolar Company d.o.o., with a focus on ensuring compliance with BAS 1049:2023. This includes detailing good animal husbandry practices, pre-slaughter management, and the identification of critical control points to prevent contamination with non-Halal substances.

Good animal husbandry practices

In the production of high-quality halal meat, the process begins with good husbandry practices on the farm, taking into account management, the slaughter process and post-slaughter management, all the way to the table[3]. The production of halal meat according to halal system requires good animal husbandry practices particularly on the animal welfare aspect starting at the farm level. Animal welfare as stated by Krishnan and others[4] are referring to the well-being of animals such as the animal care and humane treatment. Good production practice halal GMPH is the meat of animals that are allowed according to Islamic regulations, with the condition that they are properly fed and slaughtered in the manner prescribed by Sharia, it

implies plant-based nutrition without any components of animal origin.
This criterion excludes the possibility of contamination with BSE (mad cow disease).

Pre-slaughter management

The animal must be humbly unloaded from the truck, well rested and have free access to water in the stalls before slaughter. It is important to feed animals on an empty stomach for at least 12 hours before slaughter in order to reduce the migration of bacteria from the gastrointestinal tract into the meat[4]. However, prolonged food deprivation for more than 24 hours is not humane[5,6]. To ensure that the meat of animals intended for slaughter is fit for consumption, an ante-mortem examination by a competent veterinarian is of great help. Animal identification for traceability purposes, animal cleanliness, visible abnormalities, as well as indicators of animal welfare threats will be detected during the inspection[7].

(Good Manufacturing Practice of Halal -) for meat and meat products, it implies the following conditions: 1. Separation of permitted from prohibited feed, 2. Separate accommodation and separate equipment for feeding animals, 3. Separate means of internal and external transport, 4. Separate area and equipment for slaughter, 5. Separate space and equipment in the process of storage and transport and 6. Separate space and equipment in retail and distribution[1].

Slaughtering process

Slaughtering is a vital step for meat quality, safety and animal welfare[5]. In accordance with the requirements of BAS 1049:2010[3], the Halal standard is met and certification is carried out according to it by the Agency for Halal Quality Certification in Bosnia and Herzegovina[1]. Taking into account that the standard is implemented in accordance with the valid regulations in this area in Bosnia and Herzegovina, it is very important to state that the goal of both is healthy meat after slaughter. The process of slaughtering large cattle includes the following requirements:

- the animal to be slaughtered must be permitted and must be carefully treated,
- the animal must be healthy and alive, the person performing the act of slaughter must be a Muslim, mentally healthy and qualified for this activity,
- the words (in the name of Allah) must be spoken before slaughtering animals,
- the slaughtering tool must be sharp and must not be lifted from the animal until the act of slaughtering is finished, which means until the trachea, esophagus, and main arteries and veins of the neck region are cut, slaughtering is done from the front of the neck; no part may be removed before the end of the slaughter; the blood must be well drained; it is necessary to take appropriate hygienic measures on the slaughter line to avoid contamination of the meat[1].

Materials and methods

The Halal standard approved by the Institute for Standardization of Bosnia and Herzegovina is applied as such in the certification. In this part, certain documents are given that prove the implementation in Dolar Company d.o.o. The following picture shows an extract from the HALAL rules of procedure.

Picture 1. The part of Halal Manual

As the most important document for the process slaughtering of cattle is procedure for slaughtering and the next pictures show the part of that procedure.

- Altka za klanje mora biti oštra i ne smije se dizati sa životinje dok se čin klanja ne završi, a to znači dok se ne presječe dušnik, jednjak, te glavne arterije i vene vratne regije,
- Klanje se vrši s prednje strane vrata bez presjecanja kičmene moždine,
- Nijedan dio se ne smije otklanajti prije završetka klanja,
- Krv se mora dobro iscijediti,
- Potrebno je obezbijediti određene higijenske mjere da ne bi došlo do kontaminacije mesa.

Klanje se vrši ručno u visećem položaju oštrim nožem uz izgovaranje riječi Bismillah, Allahu Ekber. Rezanje vratnih žila mora uslijediti unutar 20 sekundi od podizanja životinje, a zarezane moraju biti obje karotide. U slučaju kvara i zastoja linije, radnik je dužan čim prije životinju ručno zaklati u što kraćem roku.

5.3. Okretanja prema Kibli

Postupak koji je propisan ali neobavezujući a ukoliko ga izostavimo postupak klanja ima valjanu ispravnost.

5.4. Sam čin klanja mora izvršiti musliman

Onaj koji vrši klanje mora biti:

- musliman koji praktikuje islam,
- punoljetan,
- fizički zdrav,
- mentalno sposoban,
- obučen za ovakvu vrstu posla;

5.5. Oštrina sječiva

Nož kojim se vrši klanje mora da bude izuzetno oštar, jer tupim nožem nije dozvoljeno vršiti šerijatsko klanje.

5.6. Izgovaranje Bismillah, Allahu ekber

Ispravnost halal klanja je uslovljena izgovaranjem Bismillah, Allahu ekber.

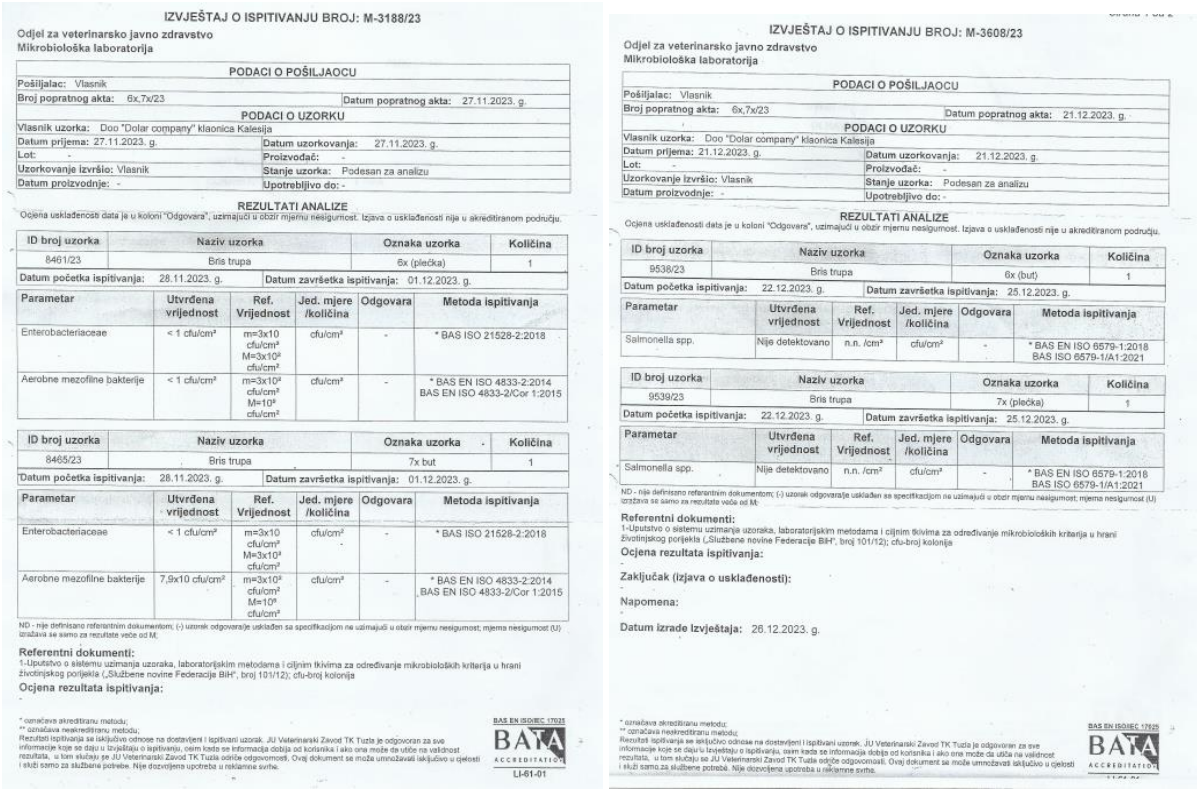
Picture 2. Description of process of slaughtering

The most importan document in HALAL implementation is the plan for the monitoring of crtical haram points and the following picture is the presentation of HrCCP plan in slaughtering in Dolar Company d.o.o.

HrKKT	Procesni korak	Kritična vrijednost/ Ciljana vrijednost	NADZOR NAD HARAM KRITIČNIM KONTROLNIM TAČKAMA					Popravne (korektivne) radnje	Odgovoran	Zapis	Verifika
			Šta	Ko	Kako	Učestalost	Gdje				
HrKKT – 1 Hr – KRITIČNA KONTROL NA TAČKA	Klanje	Klanje mora biti takvo da ne muči stoku	Pravilno obaranje stoke	Poslovo đa klaonic e	Prije početka klanja podešava se i obara stoka kako bi se izvršilo HALAL klanje	Svako klanje,	U klaonici	U slučaju da klanje nije pripremljeno i obavljeno kako treba onda se takvo meso ne može smatrati HALAL mesom	Poslovođa klaonice	Evidencija preuzete stoke na liniji primarne tehnološke obrade, VETERINARS KI OBRASCI.	Svaki pos završ smje veteri inspe poslo klao pregle obra evide ovjera svo potpi

Picture 3. HrCCP plan

As very important part of process of HALAL implementation is the analyses which show the hygienic activates as part of HALAL system e.g. and those has to be done in laboratory which has the accreditation for ISO 17025, standard for management of quality in laboratories. The following pictures show the reports form accredited laboratory.



IZVJEŠTAJ O ISPITIVANJU BROJ: M-3188/23

Odjel za veterinarsko javno zdravstvo
Mikrobiološka laboratorija

PODACI O POŠILJAOCU

Pošiljalac: Vlasnik
Broj popratnog akta: 6x,7x/23 — Datum popratnog akta: 27.11.2023. g.

PODACI O UZORKU

Vlasnik uzorka: Doo "Dolar company" klaonica Kalesija
Datum prijema: 27.11.2023. g. — Datum uzorkovanja: 27.11.2023. g.
Lot: - — Proizvođač: -
Uzorkovanje izvršio: Vlasnik — Stanje uzorka: Podesan za analizu
Datum proizvodnje: - — Upotrebljivo do: -

REZULTATI ANALIZE

Ocjena usklađenosti data je u koloni "Odgovara", uzimajući u obzir mjernu nesigurnost. Izjava o usklađenosti nije u akreditiranom području.

ID broj uzorka	Naziv uzorka	Oznaka uzorka	Količina
8461/23	Bris trupa	6x (plečka)	1

Datum početka ispitivanja: 28.11.2023. g. — Datum završetka ispitivanja: 01.12.2023. g.

Parametar	Utvrđena vrijednost	Ref. Vrijednost	Jed. mjere /količina	Odgovara	Metoda ispitivanja
Enterobacteriaceae	< 1 cfu/cm²	m=3x10 cfu/cm² M=3x10² cfu/cm²	cfu/cm²	-	* BAS ISO 21528-2:2018
Aerobne mezofilne bakterije	< 1 cfu/cm²	m=3x10² cfu/cm² M=10³ cfu/cm²	cfu/cm²	-	* BAS EN ISO 4833-2:2014 BAS EN ISO 4833-2/Cor 1:2015

ID broj uzorka	Naziv uzorka	Oznaka uzorka	Količina
8465/23	Bris trupa	7x but	1

Datum početka ispitivanja: 28.11.2023. g. — Datum završetka ispitivanja: 01.12.2023. g.

Parametar	Utvrđena vrijednost	Ref. Vrijednost	Jed. mjere /količina	Odgovara	Metoda ispitivanja
Enterobacteriaceae	< 1 cfu/cm²	m=3x10 cfu/cm² M=3x10² cfu/cm²	cfu/cm²	-	* BAS ISO 21528-2:2018
Aerobne mezofilne bakterije	7,9x10 cfu/cm²	m=3x10² cfu/cm² M=10³ cfu/cm²	cfu/cm²	-	* BAS EN ISO 4833-2:2014 BAS EN ISO 4833-2/Cor 1:2015

ND - nije definisano referentnim dokumentom; (-) uzorak odgovara/je usklađen sa specifikacijom ne uzimajući u obzir mjernu nesigurnost; mjerna nesigurnost (U) izražava se samo za rezultate veće od M.

Referentni dokumenti:
1-Uputstvo o sistemu uzimanja uzoraka, laboratorijskim metodama i ciljnim tikivima za određivanje mikrobioloških kriterija u hrani životinjskog porijekla („Službene novine Federacije BiH", broj 101/12); cfu-broj kolonija

Ocjena rezultata ispitivanja:
-

* označava akreditiranu metodu;
** označava neakreditiranu metodu;
Rezultati ispitivanja se isključivo odnose na dostavljeni i ispitivani uzorak. JU Veterinarski Zavod TK Tuzla je odgovoran za sve informacije koje se daju u izvještaju o ispitivanju, osim kada se informacija dobija od korisnika i ako ona može da utiče na validnost rezultata, u tom slučaju se JU Veterinarski Zavod TK Tuzla odriče odgovornosti. Ovaj dokument se može umnožavati isključivo u cjelosti i služi samo za službene potrebe. Nije dozvoljena upotreba u reklamne svrhe.

BAS EN ISO/IEC 17025 BATA ACCREDITATION LI-61-01

IZVJEŠTAJ O ISPITIVANJU BROJ: M-3608/23

Odjel za veterinarsko javno zdravstvo
Mikrobiološka laboratorija

PODACI O POŠILJAOCU

Pošiljalac: Vlasnik
Broj popratnog akta: 6x,7x/23 — Datum popratnog akta: 21.12.2023. g.

PODACI O UZORKU

Vlasnik uzorka: Doo "Dolar company" klaonica Kalesija
Datum prijema: 21.12.2023. g. — Datum uzorkovanja: 21.12.2023. g.
Lot: - — Proizvođač: -
Uzorkovanje izvršio: Vlasnik — Stanje uzorka: Podesan za analizu
Datum proizvodnje: - — Upotrebljivo do: -

REZULTATI ANALIZE

Ocjena usklađenosti data je u koloni "Odgovara", uzimajući u obzir mjernu nesigurnost. Izjava o usklađenosti nije u akreditiranom području.

ID broj uzorka	Naziv uzorka	Oznaka uzorka	Količina
9538/23	Bris trupa	6x (but)	1

Datum početka ispitivanja: 22.12.2023. g. — Datum završetka ispitivanja: 25.12.2023. g.

Parametar	Utvrđena vrijednost	Ref. Vrijednost	Jed. mjere /količina	Odgovara	Metoda ispitivanja
Salmonella spp.	Nije detektovano	n.n. /cm²	cfu/cm²	-	* BAS EN ISO 6579-1:2018 BAS ISO 6579-1/A1:2021

ID broj uzorka	Naziv uzorka	Oznaka uzorka	Količina
9539/23	Bris trupa	7x (plečka)	1

Datum početka ispitivanja: 22.12.2023. g. — Datum završetka ispitivanja: 25.12.2023. g.

Parametar	Utvrđena vrijednost	Ref. Vrijednost	Jed. mjere /količina	Odgovara	Metoda ispitivanja
Salmonella spp.	Nije detektovano	n.n. /cm²	cfu/cm²	-	* BAS EN ISO 6579-1:2018 BAS ISO 6579-1/A1:2021

ND - nije definisano referentnim dokumentom; (-) uzorak odgovara/je usklađen sa specifikacijom ne uzimajući u obzir mjernu nesigurnost; mjerna nesigurnost (U) izražava se samo za rezultate veće od M.

Referentni dokumenti:
1-Uputstvo o sistemu uzimanja uzoraka, laboratorijskim metodama i ciljnim tikivima za određivanje mikrobioloških kriterija u hrani životinjskog porijekla („Službene novine Federacije BiH", broj 101/12); cfu-broj kolonija

Ocjena rezultata ispitivanja:
-

Zaključak (izjava o usklađenosti):
-

Napomena:
-

Datum izrade izvještaja: 26.12.2023. g.

* označava akreditiranu metodu;
** označava neakreditiranu metodu;
Rezultati ispitivanja se isključivo odnose na dostavljeni i ispitivani uzorak. JU Veterinarski Zavod TK Tuzla je odgovoran za sve informacije koje se daju u izvještaju o ispitivanju, osim kada se informacija dobija od korisnika i ako ona može da utiče na validnost rezultata, u tom slučaju se JU Veterinarski Zavod TK Tuzla odriče odgovornosti. Ovaj dokument se može umnožavati isključivo u cjelosti i služi samo za službene potrebe. Nije dozvoljena upotreba u reklamne svrhe.

BAS EN ISO/IEC 17025 BATA ACCREDITATION

Picture 4. Results about performing of activities defined by HALAL standard in Dolar Company d.o.o.

Dscussion

The discussion on the application of HALAL standards in the slaughter of large livestock includes a number of key aspects that require careful consideration. One of these aspects is ethical factors. Many people consider the issue of ethics to be central to the debate on halal slaughter. There are different views on whether the halal method of slaughter is a humane method. Some argue that the quick cut characteristic of halal slaughter reduces the animal's suffering, while others dispute this view, arguing that it can lead to stress and suffering. This dilemma raises important questions about moral responsibility towards animals and the need for a balanced approach that takes into account both animal welfare and religious obligations.

Religious aspects also play a key role in this discussion. Halal slaughter is based on Islamic principles that prescribe certain procedures for killing animals for food. This includes saying Bismillah (in the name of Allah) before slaughter and using sharp knives to ensure quick and efficient slaughter. The discussion could focus on the interpretation of Islamic regulations on slaughter and how they apply in a modern context. It is important to consider how religious norms shape the practice of slaughter, but also how they can be reconciled with modern animal welfare standards and ethical principles.

Legal and regulatory aspects play a key role in ensuring fairness and compliance in the slaughter industry. In many countries there are regulations that regulate halal slaughter to ensure that animals are killed by humane methods. These regulations may vary across countries and jurisdictions. The question could be how these regulations affect the practice of halal slaughter and how they are implemented. Clear legal regulation is essential to ensure that slaughter is performed in a manner that respects both religious and ethical standards.

The economic impact of the halal food and slaughter industry is also an important aspect. The halal industry is becoming increasingly important globally, which has a significant economic impact. The discussion could include issues such as the economic benefits of the halal industry, market demands and challenges, and the

potential economic consequences of halal slaughter regulations. Understanding the economic dynamics of the industry can help shape policies and strategies that support sustainability and prosperity in this area.

Technological advances also have a significant impact on the practice of halal slaughter. The development of robotics and technologies that enable automated slaughtering can change the way slaughtering is carried out and how halal standards are adhered to. Discussion could focus on how these technological advances affect the practice of halal slaughter and how they can be reconciled with religious and ethical principles. It is important to ensure that technological progress supports humane and religious values and does not undermine animal welfare.

In addition to the above aspects, advances in anesthesia, surveillance and monitoring, alternative slaughter methods, genetic engineering and sustainable food production are also important factors that should be taken into account in this discussion. Overall, it is important to ensure that different perspectives and views are taken into account in order to achieve a comprehensive and informative dialogue on the application of HALAL standards in livestock slaughtering.

Conclusion

The implementation of the HALAL standard at Dolar Company d.o.o. has been shown to be comprehensive and effective, ensuring compliance with BAS 1049:2023. The detailed procedures, documentation, and hygienic analyses confirm that the company meets the necessary standards to provide Halal meat products. The discussion highlights the ethical, religious, legal, and economic implications of HALAL practices, emphasizing the importance of balancing animal welfare with religious obligations. Furthermore, technological advancements present both opportunities and challenges for the future of HALAL slaughter. Overall, the successful implementation at Dolar Company d.o.o. serves as a model for other organizations in the meat industry seeking to adopt HALAL standards.

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PRIMJENA HALAL STANDARDA U DOLAR COMPANY D.O.O. KALESIJA

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SAŽETAK

Primjena HALAL standarda u procesu klanja krupne stoke osigurava da meso i mesni proizvodi budu u skladu sa zahtjevima definiranim u BAS 1049:2023. Glavni cilj implementacije HALAL-a je pružiti potrošačima povjerenje da je meso koje konzumiraju u skladu s njihovom religijom, uvjerenjima i praksama. Uz metode klanja, halal certificiranje u mesnoj industriji također pokriva aspekte kao što su izvor sastojaka, skladištenje i transport kako bi se spriječila kontaminacija ne-halal tvarima. Ovaj rad ima za cilj prikazati proces implementacije HALAL standarda u klanju krupne stoke u Dolar Company d.o.o. Kalesija. Definiranju kritičnih kontrolnih haram tačaka posvećuje se posebna pažnja, jer hrana za stoku može biti osnovni razlog kontaminacije halal proizvoda. Također je važno spomenuti primjenjivost zakonske legislative sa zahtjevima HALAL standarda definiranim u BAS 1049:2023.

***Ključne riječi**, HALAL standard, mesna industrija, haram*

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RISK PREVENTION AND PRODUCTION OF SAFE (HALAL) FOOD THROUGH SUSTAINABLE DEVELOPMENT AS PART OF BUSINESS STRATEGY

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ABSTRACT

The food industry encompasses the activities of procurement, production, distribution, and sale of food, exerting a significant impact on the world's population. As a vital sector meeting fundamental human needs, it also carries substantial implications for the environment and society.

AS Holding Group, the largest food chain in Bosnia and Herzegovina, has embraced a business strategy that acknowledges the necessity of adapting its operations to the challenges posed by climate change and aligning with the global objectives of sustainable development by 2030. It spearheads the concept of sustainability through conscientious, steady, and balanced development, aiming to meet the present generation's needs while leaving a positive legacy for future generations.

The primary drivers of ESG (Environmental, Social, and Governance) performance in the food industry are manifested in consumer preferences, investor expectations, regulatory frameworks, implemented standards, innovations, and engagement with all stakeholders.

The objective of this research is to explore how standardizing social, environmental, food safety, and sustainability standards, along with their integration and transition, can influence the realization of company objectives while upholding ESG principles.

This paper will elucidate the implementation and integration of the new iteration of Halal BAS 1049:2023 with sustainability standards such as RSPO (Roundtable on Sustainable Palm Oil) and RA (Rainforest Alliance) within the confectionery industry's supply chain, highlighting the benefits for all involved stakeholders. Enterprises transitioning towards renewable energy sources, curbing CO2 emissions, instituting recycling and waste management practices, reducing organic waste, embracing advanced technologies for minimal processing, and adhering to the trends and requirements of global food safety initiatives (GFSI) enhance and fortify their ESG performance.

To showcase the application of ESG principles within AS Holding's subsidiaries, a questionnaire was administered, yielding results that underscore the correlation between adherence to ESG principles, commitment to tools, and adherence to standard requirements with business viability, competitiveness, market independence, transparency, and a sustainable future.

Keywords: *food industry, integrated standards, halal BAS 1049:2023, ESG, product safety, sustainability.*

INTRODUCTION

With the development of new products and a greater presence in the global market, AS Holding and its subsidiaries recognize the necessity of adapting business operations to the challenges posed by climate change and aligning with the global sustainable development goals by 2030, with a focus on the safety and security of finished products. Within the largest food chain, the companies engage in core activities such as:

- Production and packaging of roasted and ground coffee, instant coffee, tea, soups, spices, and sweet powdered products, snack products, repackaging of parboiled rice, production and packaging of ready-made risotto blends, production of instant suti mixture.
- Fruit and vegetable procurement and processing company;
- Processing and production of milk and dairy products;
- Extraction and bottling of natural spring and mineral water;
- Production and sale of milling and bakery products, animal feed products;
- Development, production, and sale of standard and special types of bread and pastry flour, frozen semi-finished dishes, biscuits, tea cakes, sweets, pasta, and tahan halva;
- Cocoa bean processing and production of cocoa products, Chocolate production, Cream spread production, Jelly-filled biscuit production, Chocolate-coated biscuit production, Petit biscuit production, Tea ring production, Soup cube production, Spice blend production, Cocoa instant drink production, Pectin jelly production;
- Salt extraction, salt production;
- Production and distribution of food products;
- Logistics.

The priority in our work is to establish a balance between market growth and sustainable development, which represents a fundamental factor in the development of society for current and future generations. Through implemented and integrated management systems, companies have identified risks, adopted risk management matrices aimed at achieving safe and healthful products. In order to establish a balance and increase awareness of sustainable development within business operations, basic requirements of ESG standards are being introduced. Environmental standards relate to the company's impact on the environment through the consumption of natural resources and raw materials. Social standards pertain to the company's impact on society, which is reflected in promoting workers' rights, diversity and inclusivity in the workplace, ensuring good labor practices through procurement systems, and collaborating with local communities. Management standards refer to practices and procedures adopted and implemented within the company to ensure compliance with laws and integrated standards arising from the requirements of stakeholders.

The Halal standard, as one of the integrated standards within companies, is compatible with other international standards governing quality management systems (ISO) and is in accordance with the Halal standards of the Organization of Islamic Cooperation (OIC/ S). Companies within AS Holding will align their implemented standard with the new revision requirements of BAS 1049:2023 by the year 2024. Sustainable standards in the production of confectionery products include integration of RA (Rainforest Alliance) and RSPO (Roundtable on Sustainable Palm Oil). Environmental management is regulated by the implemented and integrated ISO 14001:2015 standard, while health and safety at work are addressed by implementing ISO 45001:2018. The social aspect is defined by an ethical code and adopted internal policies in line with legal regulations, BSCI standards, and implemented ISO 37301.

The RA (Rainforest Alliance) standard focuses on food production processes such as coffee, cocoa, tea, bananas, and many other foods facing ecological and social challenges. The primary

goal of this sustainable RA standard is forest conservation, climate change mitigation, protection of human rights, and ensuring livelihoods for rural communities in the agricultural supply chain.

Certification according to the RSPO standard represents an assessment process of the supply chain and all its key components, their policies, and operational procedures for compliance validation by an independent third-party body, related to the following:

- Compliance with local and international laws and regulations
- Demonstrating a long-term focus on financial and economic sustainability
- Utilizing best agricultural practices by growers and millers
- Environmental responsibility, including the preservation of natural resources and biodiversity
- Preserving the well-being of employees and communities affected by cultivation or processing
- Responsible management of new plantings
- Focus on continuous improvement

All implemented and integrated standards ensure fair and transparent management, disclosure of information, prevention of corruption, and enable diversity while creating equal opportunities, transparent decision-making processes, and IT security.

MATERIALS AND METHODS

The research encompassed subsidiaries of AS Holding from the Sarajevo Canton, Tuzla Canton, Una-Sana Canton, and Zenica-Doboj Canton areas, and it was conducted through a questionnaire that addressed the basic requirements of sustainable development goals until 2030. Figure 1 depicts the 17 goals with the year 2030.

1. Eradication of poverty
2. Eradication of hunger
3. Health and well-being
4. Quality education
5. Gender equality
6. Drinking water and hygienic conditions
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reducing inequality
11. Sustainable citizens and sustainable communities
12. Responsible consumption and production
13. Response to climate change
14. Life under water
15. Life on land
16. Peace and justice/strong institutions
17. Partnership for goals[1]

Figure 1. 17 Sustainable Development Goals by 2030

[1] https://ksapa.org/an-antidote-for-sdg-washing-5-key-progress-points-for-businesses-and-investors-to-uphold-the-2030-agenda/

With the year 2024, members within the AS Holding group will create and implement a new edition of Halal documentation and operating systems in accordance with the new revision of BAS 1049:2023. Unlike the BAS 1049:2010 standard for Halal quality, the BAS 1049:2023 standard includes references to six new standards applicable in this standard: OIC SMIIC 1, CAC/RCP, CAC/RCP 58, CODEX STAN 1, BAS ISO 22002, BAS ISO 22005.
In BAS 1049:2023, the standard version has been supplemented with terms and definitions that are not found in the 2010 version. Those added in the 2023 version include: enzymes, genetically modified food, food, microorganisms, processing aids, food additives, prerequisite programs (PRPs), aquatic animals, amphibians, food safety.

Considering that AS Holding is a leading group in the food sector, market growth and development are primarily reflected through the quality of the finished products they offer. In order to meet the requirements of all stakeholders, the members practice the integration of implemented standards in the area of business quality.
In response to the requirements, some members have integrated sustainable development standards (RSPO and RA) with the requirements of HALAL standard BAS 1049:2023, thereby streamlining operations in terms of good manufacturing practices and internal as well as external communications within AS Holding.

The implementation of fundamental principles within AS Holding has been assessed based on a survey completed by 10 members of the food sector. The survey questions were formulated from basic requirements in environmental, social, and managerial aspects, which form the basis of the ESG strategy as well.

RESULTS AND DISCUSSION

Reducing the negative environmental impact, which includes effective waste management and investment in renewable energy sources, is being implemented at the level of AS Holding, as evidenced by the results of the conducted survey.

Among the surveyed members of the food sector, four members, or 40%, are holders of ISO 14001:2015 certification, indicating a commitment to structured environmental management. Additionally, six members (60%) possess environmental permits and meet the basic requirements of legal regulations, demonstrating adherence to environmental standards within the legal framework.

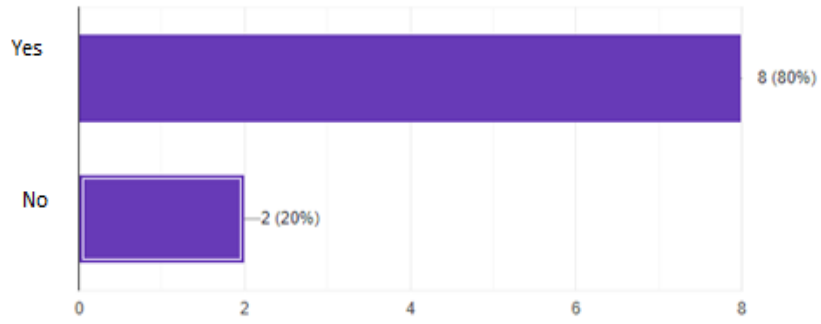

Diagram 1. Percentage of Responses to the Question: Has your company recognized the use of solar panels as a form of energy efficiency?

Based on the data shown in Diagram 1, we can conclude that AS Holding has a very satisfactory awareness regarding investment in renewable energy sources. The use of solar panels is considered one of the cleanest and environmentally friendly methods of electricity

production in the future for companies within AS Holding.

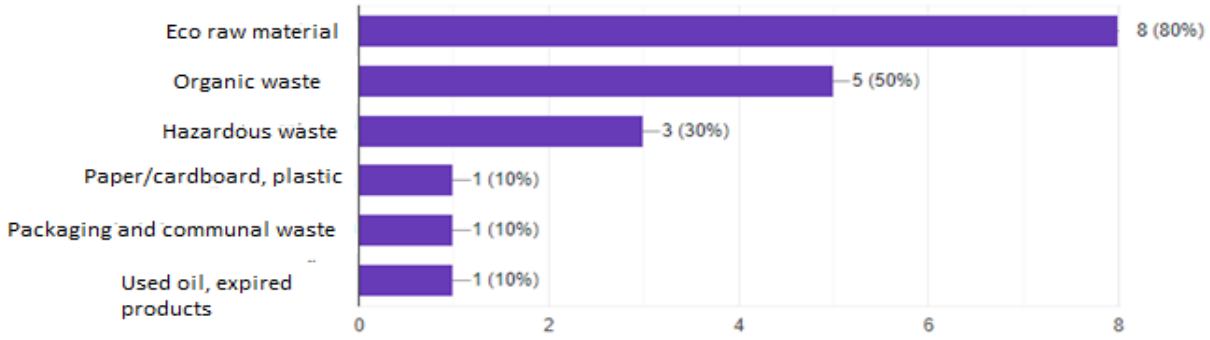

Diagram 2: Percentage Breakdown of Responses to the Question: How do you manage waste disposal?

Based on the data presented in Diagram 2, it is evident that the members effectively manage all types of waste generated during and after the production process.

Business strategy of AS Holding to reduce negative environmental impact is reflected through investments in renewable energy sources and promoting the use of sustainable resources. The most important aspect of this policy is that there is no waste at any stage of production, but rather waste is turned into profit.

Diagram 3 shows data on certified social standards within AS Holding. Two companies possess ISO 45001 certification, defining a system for occupational health and safety. By implementing ISO 45001 requirements, the possibility of work-related injuries is minimized, the health of employees is protected, and safe and healthy workplaces are ensured.

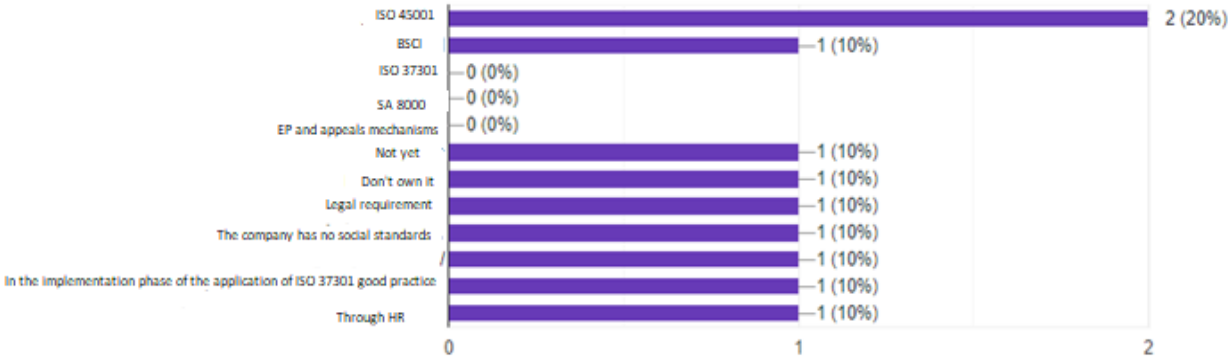

Diagram 3: Percentage Breakdown of Responses to the Question: Which social standards does your company possess?

To achieve social development, AS Holding promotes diversity and inclusivity in the work environment, ensures fair labor practices throughout its supply chains, and collaborates with local communities. The survey results indicate that 80% of the members have actively included workers with various forms of disabilities who are equally integrated into the work system.

Within the surveyed companies, 70% have adopted ethical codes aimed at promoting business ethics, good business practices, principles of awareness and integrity, as well as ensuring transparency. Diagram 4 illustrates the areas that the code additionally covers.

Diagram 4: Percentage Breakdown of Responses to the Question: If you have an ethical code, which areas does the ethical code cover?

Employee motivation, as an essential resource for company development, is reflected not only through internal and external education but also through incentives implemented by 60% of the surveyed companies. Among these companies, 70% have signed and aligned collective agreements with employee representatives, while 60% of companies have procedures and systems for monitoring and improving working conditions and the work environment.

To meet the requirements for monitoring potential violations of legal obligations in areas such as inequality and gender equality, as well as protecting client data, companies adhere to the provisions of the Labor Regulations and the Security and Personal Data Plan.

Security and health of customers are top priorities for AS Holding, consistently guided by the highest standards of product quality and safety for years. To more effectively achieve quality goals, ISO 9001:2015 standards have been implemented in 80% of the surveyed companies. This standard represents a cornerstone of quality management upon which other management systems have been subsequently integrated. These include ISO 14001:2015 for Environmental Management Systems, ISO 45001:2018 for Occupational Health and Safety Management Systems, RA and RSPO standards, as well as food safety and security standards as listed in Diagram 5.
As of 2024, out of a total of nine companies that hold Halal standards, four have completed the documentation and system revision according to the new edition of BAS 1049:2023, while one company is currently undergoing revision. Taking into account the new edition, there have been no changes in the number of haram critical control points, and the same haram critical control point remains, which is the procurement process for the surveyed companies.

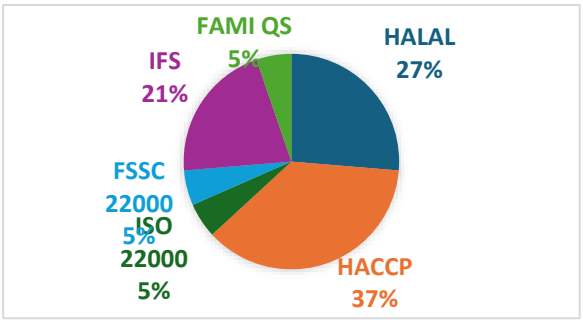

Diagram 5: Percentage Breakdown of Responses to the Question: Which food safety and quality standards does your company possess?

Since the requirements for halal and kosher diets share some common characteristics, such as restrictions on certain types of meat and the method of slaughtering, consuming kosher food that does not contain alcohol can be considered a practical solution when halal options are limited. Muslims may choose kosher food if halal options are not available due to travel, location, or other circumstances.

In companies that use animal-derived ingredients, collaboration with suppliers who adhere to Halal standards is mandatory. Two companies within

AS Holding meet the requirements of the RA and RSPO standards for grains and palm oil.

The Halal requirement also addresses the issue of genetically modified food, specifying that such ingredients or similar products cannot be used in the preparation of halal products. In line with this, one company within the group possesses NON GMO certification and responsibly markets GMO-FREE animal feed to meet market demands.

Companies that possess both Halal and RSPO/RA standards have efficiently integrated their systems to meet these requirements:

1. **Procurement Departments' Responsibilities**: Member procurement departments are tasked with sourcing raw materials from suppliers who meet the requirements of all implemented and integrated systems. This means that cocoa beans and palm oil, as raw materials used in production, must adhere to both Halal and RSPO/RA standards.
2. **Storage Requirements**: The requirement for storing RSPO/RA materials is that they must be separated from other materials by 1 to 2 meters, which is also a requirement for Halal materials to be separated and clearly marked from other non-permissible materials.
3. **Traceability Requirement**: Accurate data regarding the purchased Halal and sustainably sourced materials must be known, including the exact quantity used in the production process (both in the finished product and by-products).
4. **Production Line Segregation**: Production lines must be clearly marked to prevent cross-contamination with non-permissible or non-sustainable materials.

These measures ensure compliance with both Halal and sustainable sourcing standards throughout the production process, maintaining product integrity and meeting consumer expectations.

According to the conducted survey, market demands for sustainable products are increasing, with up to 50% visibility in these companies within AS Holding. This will result in an increased certification process within AS Holding and enhance product visibility in the market. This trend indicates a growing consumer awareness of sustainability and environmental issues, and companies that manage to align their products with these demands will have a competitive advantage. AS Holding will likely need to invest more in certifications and marketing activities to highlight its sustainability advantage and attract more conscientious consumers.

CONCLUSION

Based on the conducted survey, monitoring documentation, and processes according to the new revision of the Halal standard BAS 1049:2023 and integration with RSPO and RA sustainable development standards, it can be concluded that the AS Holding group implements a business strategy that recognizes the necessity of adapting its operations to the challenges posed by climate change and aligning with global sustainable development goals by 2030.

Out of the total surveyed 10 members within the AS Holding group, nine possess the Halal standard, with five of them already having revised their documentation and aligned their production lines and processes with BAS 1049:2023. This demonstrates a proactive approach towards meeting industry standards and ensuring product quality and compliance with evolving regulatory requirements.

As a critical control point in the Halal standard and a fundamental requirement of implemented sustainable development standards, the procurement process is key. This means no raw material can enter the manufacturing company without having a "halal" status. By incorporating the requirements of RSPO and RA standards, the supply chain from suppliers to consumers is ensured to be aligned with both Halal and sustainability principles. This ensures that the sourcing of materials is ethical, environmentally responsible, and compliant with Halal standards, meeting the expectations of both Halal consumers and sustainable practices.

Based on the presented results of standardization in social, environmental, food safety, and sustainability standards, along with their integration and transition, it is evident that the

basic requirements of ESG (Environmental, Social, Governance) strategy are being met.
In many countries, Halal living is a lifestyle choice that extends into segments such as Halal baby food, indicating its potential as a growing sector in the coming years. Muslims currently spend around $1.3 trillion on food and beverages, a figure predicted to reach $1.9 trillion. The opportunities and challenges in the Halal food market are becoming highly promising segments for both products and services.

This highlights the importance of adhering to Halal standards and integrating sustainability practices, not just as ethical considerations but also as strategic business moves to tap into a significant and expanding market segment. AS Holding's focus on these standards positions it well to capitalize on these opportunities while meeting consumer demands and regulatory requirements.

AS Holding can serve as an example and driver of positive changes that will promote sustainable development not only in Bosnia and Herzegovina but also on a global scale. This mindset and approach have ensured AS Holding's competitiveness in both domestic and international markets, leading to excellent business results while respecting social and environmental responsibilities. By striving to minimize harmful impacts on the environment, AS Holding demonstrates its commitment to sustainability and responsible business practices, setting a benchmark for other companies to follow. This proactive approach not only benefits the company's bottom line but also contributes to a healthier and more sustainable future for communities and ecosystems.

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PREVENCIJA RIZIKA I PROIZVODNJA SIGURNE (HALAL) HRANE KROZ ODRŽIVI RAZVOJ KAO DIO POSLOVNE STRATEGIJE

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SAŽETAK

Prehrambena industrija obuhvata delatnost nabavke, proizvodnje, distribucije i prodaje hrane, koja ima značajan uticaj na svjetsko stanovništvo. Kao vitalni sektor koji zadovoljava osnovne ljudske potrebe, on takođe nosi značajne implikacije na životnu sredinu i društvo. AS Holding grupa, najveći prehrambeni lanac u Bosni i Hercegovini, prihvatila je poslovnu strategiju koja prepoznaje neophodnost prilagođavanja svog poslovanja izazovima koje postavljaju klimatske promjene i usklađivanja sa globalnim ciljevima održivog razvoja do 2030. godine. Ona predvodi koncept održivost kroz savjestan, stabilan i uravnotežen razvoj, s ciljem zadovoljavanja potreba sadašnje generacije, ostavljajući pozitivno nasljeđe budućim generacijama. Primarni pokretači performansi ESG (Okoliš, društvo i vlada) u prehrambenoj industriji manifestuju se u preferencijama potrošača, očekivanjima investitora, regulatornim okvirima, implementiranim standardima, inovacijama i angažmanu sa svim zainteresovanim stranama.

Cilj ovog istraživanja je utvrditi kako standardizacija društvenih, ekoloških, standarda sigurnosti hrane i održivosti, zajedno sa njihovom integracijom i tranzicijom, može uticati na realizaciju ciljeva kompanije uz pridržavanje ESG principa. Ovaj rad će razjasniti implementaciju i integraciju nove iteracije Halal BAS 1049:2023 sa standardima održivosti kao što su RSPO (Okrugli sto o održivom palminom ulju) i RA (Rainforest Alliance) unutar lanca opskrbe konditorske industrije, naglašavajući prednosti za sve uključene. zainteresovane strane. Preduzeća koja prelaze na obnovljive izvore energije, smanjuju emisiju CO2, uvode prakse recikliranja i upravljanja otpadom, smanjuju organski otpad, prihvaćaju napredne tehnologije za minimalnu preradu i pridržavaju se trendova i zahtjeva globalnih inicijativa za sigurnost hrane (GFSI) poboljšavaju i jačaju svoje ESG performanse.

Kako bi se prikazala primjena ESG principa u podružnicama AS Holdinga, administriran je upitnik koji je dao rezultate koji naglašavaju korelaciju između pridržavanja ESG principa, posvećenosti alatima i pridržavanja standardnih zahtjeva s poslovnom održivošću, konkurentnošću, tržišnom neovisnošću, transparentnošću i održiva budućnost.

Ključne riječi: *Prehrambena industrija, integrirani standardi, Halal BAS 1049:2023, ESG, sigurnost proizvoda, održivost.*

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HALAL HYGIENE AND SANITATION

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Professional paper

ABSTRACT

Today, due to advances in non-thermal plasma (NTP) or atmospheric cold plasma (ACP), the halal industry can experience significant improvement in its standard operating procedures for air, surface and water disinfection and decontamination.

Providing a continuous, pervasive, stable and consistent level of biosecurity further ensures the prevention and reduction of harmful volatile organic compounds and microbes throughout the food supply chain. Proven against the most common food safety issues, from slaughter to processing, packaging and transportation, your halal food products can now experience the best possible disinfection and hygiene. These activities will contribute directly to the achievement of the strategic objective of food biosecurity, which aims to enable inclusive and efficient agri-food systems and is consistent with the Halal Regulation in specific aspects. This occurs through an organizational output: international standards, agreements and voluntary policies formulated to improve countries' access to and functioning of international markets. Through the issue, new and revised international standards and new technical procedures for food safety, quality and phytosanitary health are formulated and agreed by countries, serving as a reference for international harmonization.

The use of NTP or ACP improves all processes through its ability to quickly neutralize microbes, affect the actual product in the process, improve indoor air quality, provide plasma activated water and neutralize microbes that can affect the quality of the product. The latest area of research from the United States Department of Agriculture (USDA) is the use of NTP or ACP to improve the shelf life of produce. Due to the organic nature of the disinfectant produced in the plasma chamber, it was determined that the product does not undergo any physical or nutritional changes that can occur with irradiation. Non-thermal plasma (NTP) technology provides an innovative and effective dry surface cleaning method that offers several advantages over traditional wet cleaning techniques and also offers a unique and effective method for treating water, particularly in the contexts of disinfection and pollutant degradation. So NTSP helps in maintaining rigorous hygiene standards required in the halal food industry. During this session, you will learn how is Non-thermal plasma (NTP) technology is increasingly recognized for its potential in biosecurity applications due to its ability to inactivate a broad range of pathogens and about the extensive benefits and ongoing developments and improvements that USDA says are possible for using non-thermal plasma or cold atmospheric plasma to integrate this technology into halal food products.

Keywords: *Hygiene, Halal, Non-thermal plasma, Atmospheric cold plasma.*

Introduction

This paper was written as a business paper to provide insight into how non-thermal or atmospheric cold plasma has played and can continue to play a critical role in the future of not only halal but in food safety throughout the entire food supply chain. The research papers used to develop this paper are cited after the conclusion.

Food is not only an essential source of nourishment but also a source of pleasure, especially when it comes to meat. Meat contains several essential nutrients, including proteins, lipids, vitamins, and minerals (Biesalski, 2005). Several factors can influence meat quality during processing and storage and controlling these factors is important in the meat industry in order to ensure optimal quality and consumer satisfaction.

Of Ensuring food safety has been and remains a key objective for governments and policymakers, food industry, and researchers worldwide.

Nevertheless, new challenges may be posed by, inter alia, the increasing complexity of food supplies, accelerating climate change, intensifying international food trade, new food sources and technologies, circular economy, and sprawling urban agriculture. (Food and Agriculture Organization [FAO], 2022).

The most important aspect of any food safety program's standard operating procedure (SOP) and stringent hazard analysis and critical control point (HACCP) is rooted in proper hygiene and sanitation practices. For the purpose of this paper these two definitions apply:

1. Hygiene is defined as the practice of keeping yourself and your surroundings clean, especially in order to prevent illness or the spread of diseases.
2. Sanitation is the process of keeping places free from dirt, infection, disease, etc., by removing waste, trash and garbage, by cleaning food production spaces, etc.

Concentrating on safety, security, and sustainability is part and parcel of the EU's current pathogen management strategy, which has been summarized by May 2020 strategy paper From Farm to fork.

Currently, many efforts have been made to develop more effective halal-authentication detection systems.

Without the proper combination of hygiene and sanitation diseases can spread throughout the food chain. This paper will focus on the boxed area of the below diagram. By properly utilizing a proven non-thermal plasma (NTP) or atmospheric cold plasma (ACP) disinfection biosecurity solution we can successfully address the stringent hygiene and sanitation required in halal foods production. Implementing this technology throughout the food chain it is possible to reduce the potential for cross contamination from disease and other unwanted bioburden, volatile organic compounds (VOCs) and microbials.

Why the focus on non-thermal plasma over the years?

- Different temperatures can be achieved for different plasma species, mostly around room temperature.
- Uses energy more efficiently at low temperatures to gain better chemical selectivity/reactivity
- The electron temperature governs ionization and chemical processes
- Metastable state with a roughly zero net electrical charge.
- Only nonthermal plasma is applied to food products.

Mode of Action of Cold Plasma:

Plasma, which has been described as the fourth state of matter, is partially or fully ionized gas composed of positive and negative ions, electrons, free radicals, and neutral particles (Nehra et al., 2008). It is generated by applying an electric current across neutral gases, which results in the dissociation of the gaseous molecules (Conrads and Schmidt, 2000; Nehra et al., 2008). Plasma can be divided into two types based on temperature: high temperature plasma and low temperature plasma.

- High temperature plasma exists in a thermal equilibrium state in the range of 10 to 10 K (Nehra et al., 2008).
- Low temperature plasma can be further divided into thermal or nonthermal plasma. Thermal plasma exists in a local thermal equilibrium state with temperatures ranging from 4000 to 20,000 K (Bogaerts et al., 2002; Schluter et al., 2013).
- Non-thermal plasma, also known as cold plasma, exists in a non-equilibrium state with a temperature range of 300 to 1000 K (Nehra et al., 2008). High temperature and thermal plasmas are not suitable for use on heat sensitive foods because the heat transfer from the plasma to the food causes deterioration in the food's quality. Therefore, non-thermal plasma methods of pasteurization are of considerable interest to the meat industry. (1)

Intertwining of Halal and Tayyib

A balanced relationship between halal and food safety (Tayyib) control adds value in the food chain and improves confidence among Muslim consumers and those with various religious backgrounds. In addition, the advance of globalization and new processing technologies, new distribution strategies, new challenges and

new risks, different ingredients and preparation methods have exposed Muslims to uncertainty in identifying halal or haram due to ambiguity (Zunira Talib et al., 2010).

Maintaining high standards of hygiene and sanitation is crucial in Halal food production to ensure that the food not only meets religious compliance but is also safe and wholesome for consumption. Halal hygiene and sanitation practices encompass various aspects of food handling, processing, and storing, aligning with the principles of both **Halal** (lawful) and **Tayyib** (pure and wholesome).

Key *objectives* for compliance to providing halal food products include:

1. *Control of cross contamination* between halal and no-halal foods but more importantly of impure substances such as *bioburden including microbials such as viruses, bacteria, molds and fungi.*
2. Use *Halal certified* ingredients, *cleaning agents and processing equipment* used throughout the food supply chain.
3. Avoid the use of *chemicals and pesticides.*
4. Halal slaughtering methods are conducted in a manner prescribed by Islamic law, which includes reciting the name of God at the time of slaughter, *ensuring the animal is healthy* at the time of the slaughter.
5. Properly address any potential of *microbial contamination* from waste disposal.
6. Use of *pure, safe water* in the processes and packaging.

The focus of halal is determining what is permitted. While certain aspects of ensuring halal are clearly stated, the process for ensuring halal environments can be improved. Incorporating tayyib into all halal food production facilities will only enhance the efforts in providing the permitted foods. Tayyib will create a more intense focus on hygiene, sanitation and disinfection throughout the food chain, ensuring the food is not only permissible but also beneficial for health and well-being.

The intertwining of halal and tayyib changes the market appeal of halal/tayyib produced foods. By producing food in a more ethic and environmentally friendly method, it sends a powerful message possibly commanding more widespread use of halal/ tayyib foods. Therefore, the products could demand a higher market value.

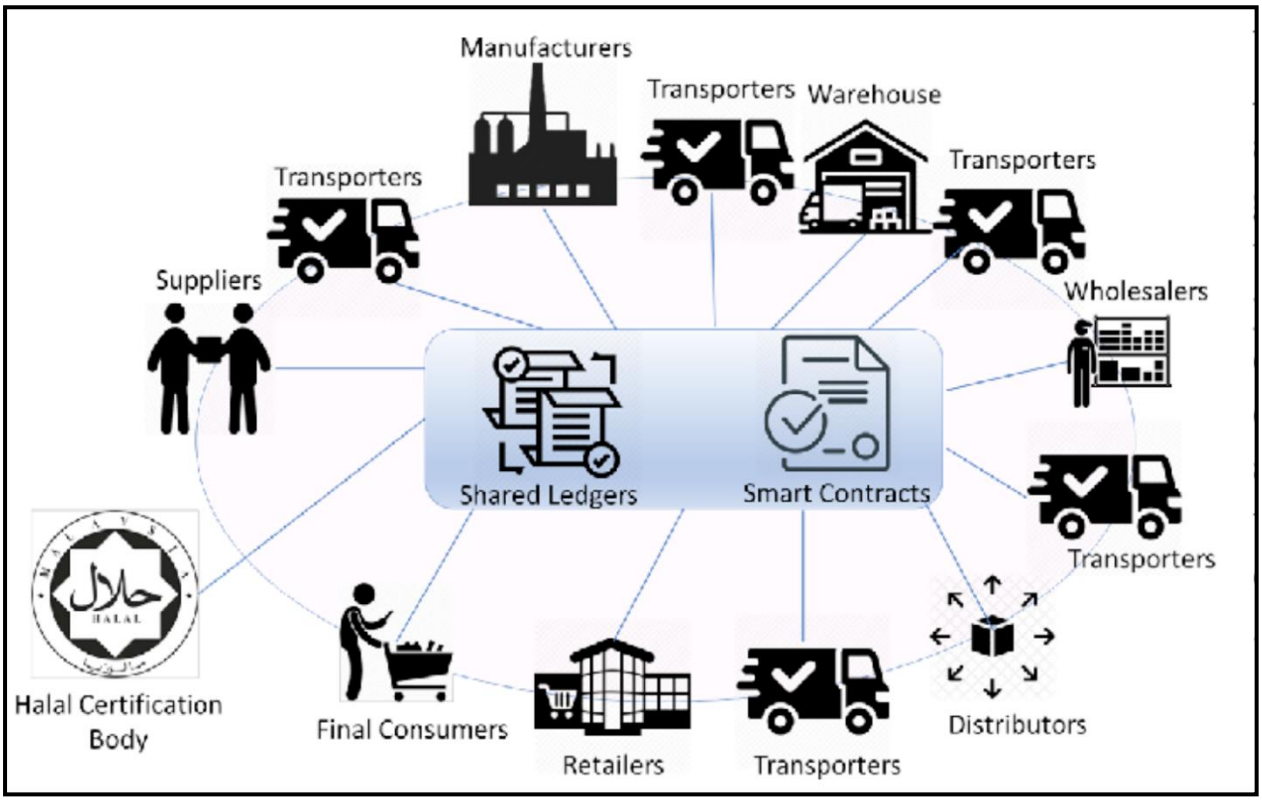


Figure 1. Introducing Non-Thermal Plasma or Atmospheric Cold Plasma into Halal/Tayyib

Non-thermal plasma (NTP) technology is increasingly recognized for its potential in biosecurity applications due to its ability to inactivate a broad range of pathogens, including bacteria, viruses, fungi, and spores, without the use of chemicals. Non-thermal plasma can be employed in halal food production facilities to enhance biosecurity measures in various settings. NTP can be used to sanitize livestock environments and equipment, reducing the risk of disease transmission among animals. (6) For instance, treating air or surfaces in barns and poultry houses can help in managing outbreaks of diseases like avian influenza or swine fever. In crop production, NTP can treat seeds or plants to eliminate surface pathogens, reducing the spread of plant diseases without chemical pesticides. (10)

NTP is effective in reducing microbial contamination on both food products and packaging materials, enhancing food safety and extending shelf life without altering the food's quality or nutritional value. (2)

Non-thermal plasma can be used to treat water, effectively destroying pathogens and degrading pollutants, making it a valuable tool for securing safe drinking water supplies and managing wastewater. (12)

NTP systems can inactivate airborne pathogens and reduce the spread of diseases in enclosed spaces like buildings, public transport, and aircraft.

Non-Thermal Plasma (NTP) technology addresses all the objectives for compliance to providing halal food products. By promoting tayyib, NTP may be the best economic solution that properly provides the needed approach for the intertwining of halala and tayyiba. As a result, from farm to fork, from crop to cup will have an increased level of purity and safety to promote high quality and healthy food products globally.

Non–Thermal Plasma Enhances SOP and HACCP

Advances in non-thermal plasma (NTP) technology could indeed bring substantial improvements to the halal industry, especially in enhancing standard operating procedures (SOP) and hazard analysis and critical control point (HACCP) to include tayyib process for disinfection and decontamination of air, surfaces, and water. NTP can contribute to your SOP and HACCP in several key ways.

Applying NTP at specific stages, such as post-harvest or pre-packaging, can be designated as

critical control points. This is where intervention is crucial to prevent microbial contamination. Various reactive species enables it to effectively inactivate airborne pathogens, including bacteria, viruses, and fungi. These agents damage microbial DNA and cellular structures, leading to the inactivation of these pathogens. NTP can influence the size distribution and concentration of aerosols in the air. NTP can also neutralize allergens and other irritants in the air. The reactive species can break down allergenic proteins or render them non-allergenic, thus improving air comfort and healthiness. The same reactive species also have strong antimicrobial properties, capable of killing bacteria, viruses, and fungi on surfaces, which is especially useful for hygiene-critical environments like hospitals, food processing facilities, and cleanrooms. (13)

Non-thermal plasma (NTP) technology provides an innovative and effective dry surface cleaning method that offers several advantages over traditional wet cleaning techniques. NTP cleaning is particularly valuable for applications where the use of liquids is undesirable or where minimal residue and low environmental impact are priorities. NTP technologies are known for their ability to effectively eliminate microbes and pathogens in air and on surfaces without the need for high temperatures or harsh chemicals. This is particularly useful in the halal industry, with tayyib principles maintaining cleanliness and purity is essential.

These technologies do not rely on chemical disinfectants, which aligns well with halal and tayyib principles that emphasize safety and natural processes. NTP is considered a more "organic" or natural approach to various applications compared to processes that involve harsh chemicals or additives. This can help in preventing chemical residues in the air, on surfaces and in water, which is crucial for processes where purity is paramount, such as in food production or water purification. Non-thermal plasma (NTP) achieves the complete dissociation of molecules through its unique physical properties and mechanisms. The dissociation processes in NTP generate a variety of reactive species, including radicals (e.g., hydroxyl radicals, superoxide), which are highly reactive and can further interact with and break down other molecules breaking chemical bonds. The result is the dissociation of molecules into atoms or simpler molecules. Therefore, no harmful by-products are created due to complete dissociation.

Effectiveness in managing insect populations stems from its ability to generate reactive species and highly charged molecules, which can directly impact insects at various life stages. These agents can cause direct physical damage to the insects' bodies, disrupt their respiratory systems, or induce oxidative stress that damages cellular components. NTP can be used to protect crops from insect pests without the use of chemical pesticides. NTP can be employed in storage facilities and processing plants to control insects that contribute to food spoilage and contamination, such as weevils, moths, and beetles. (8) The effects of NTP on insects are immediate, which is beneficial for rapidly addressing severe infestations. NTP does not leave harmful residues that could contaminate crops, water, or affect non-target wildlife, making it safer than traditional chemical treatments. (3)

The application of these plasma technologies in food preservation could also benefit the halal industry by extending the shelf life of perishable products without the use of chemical preservatives, thus maintaining the natural quality of the food adhering to halal and tayyib (wholesomeness) principles. (7) By reducing the microbial load on fresh produce and packaged goods, NTP can extend the shelf life of these products. Longer shelf life is particularly beneficial in reducing food waste and enhancing the economic viability of transporting and storing halal food products over long distances. The use of NTP may provide the solution required by a new standard for the export and import of food products to demonstrate its purity. (5)

NTP can also be used to sterilize packaging materials used for halal foods. NTP effectively reduces surface pathogens on food products and packaging. This application ensures that the packaging does not become a source of contamination. Sterilizing packaging with NTP enhances food safety and quality, supporting compliance with both halal standards and global food safety regulations.

Non-thermal plasma (NTP) offers a unique and effective method for treating water, particularly in the contexts of disinfection and pollutant degradation. Its ability to generate a mix of reactive species without significantly increasing

water temperature makes it suitable for various applications. Using NTP to treat water used in the food processing industry ensures that it is free from harmful microorganisms and chemicals. This application ensures that the water used in the preparation, processing and wash downs of halal food processing facilities meet the highest standards of purity, crucial for washing and preparing foods according to halal regulations.

Chill water plants, essential components in centralized air conditioning systems for large buildings, require constant maintenance to ensure efficiency and prevent issues like microbial growth and scaling in the water circuits. Chill water systems can suffer from the growth of biofilms on heat exchanger surfaces and within piping. Biofilms reduce system efficiency by impairing heat transfer and can contribute to corrosion and clogging of pipes. NTP can effectively control biofilm formation and reduce microbial populations in the water.

The reactive species generated by NTP, such as ozone, reactive oxygen, and nitrogen species, have potent antimicrobial properties that disrupt biofilm matrices and kill the microorganisms they contain. Traditional water treatment methods often involve chemicals that can be harmful to the environment and may require careful handling. NTP can be used to purify and treat the water without the addition of chemical disinfectants. This treatment can reduce the concentrations of harmful pathogens, degrade organic contaminants, and even control the levels of certain chemicals. Corrosion and scaling are significant issues in chill water systems, leading to reduced efficiency and the potential need for costly repairs and downtime.

By improving water quality and reducing microbial content, NTP can indirectly help minimize conditions that lead to corrosion and scaling. Cleaner water means less scaling and reduced corrosion rates on metal surfaces. NTP offers an environmentally friendly alternative to chemical treatments. It reduces the need for chemical use in chill water systems, decreasing the environmental impact associated with chemical storage, handling, disposal, and potential spills. By treating the chill water system with NTP it prevents pathogens form being transmitted wherever the chill water system may aerosolize droplets. As a result, you can help reduce the likelihood of diseases such as legionella.

NTP can be used to remove odors from food products without chemical additives. This is especially useful in meat processing and spice treatment. Removing odors while maintaining the natural flavor and compliance with halal standards enhances the consumer acceptability of food products. The reactive species produced by NTP are also effective in neutralizing odors. They can chemically alter the structure of odor-causing molecules, rendering them odorless. NTP can break down VOCs without creating any byproducts due to complete dissociation. The result of the dissociation of a VOC is H, O and molecular C. Effective on formaldehyde, ethylene (rapid ripening agent for some produce), ammonia, and other contaminants of concern as per ASHRAE. (4)

It's essential that the use of NTP in halal food processing is recognized and certified by halal certification bodies. Compliance with both technical and religious standards must be ensured.

By incorporating NTP into halal food production, businesses can leverage advanced technology to support sustainability, enhance product safety and quality while adhering to strict halal principles. This integration not only aligns with Islamic dietary laws but also addresses broader consumer demands for ethical and safe food practices.

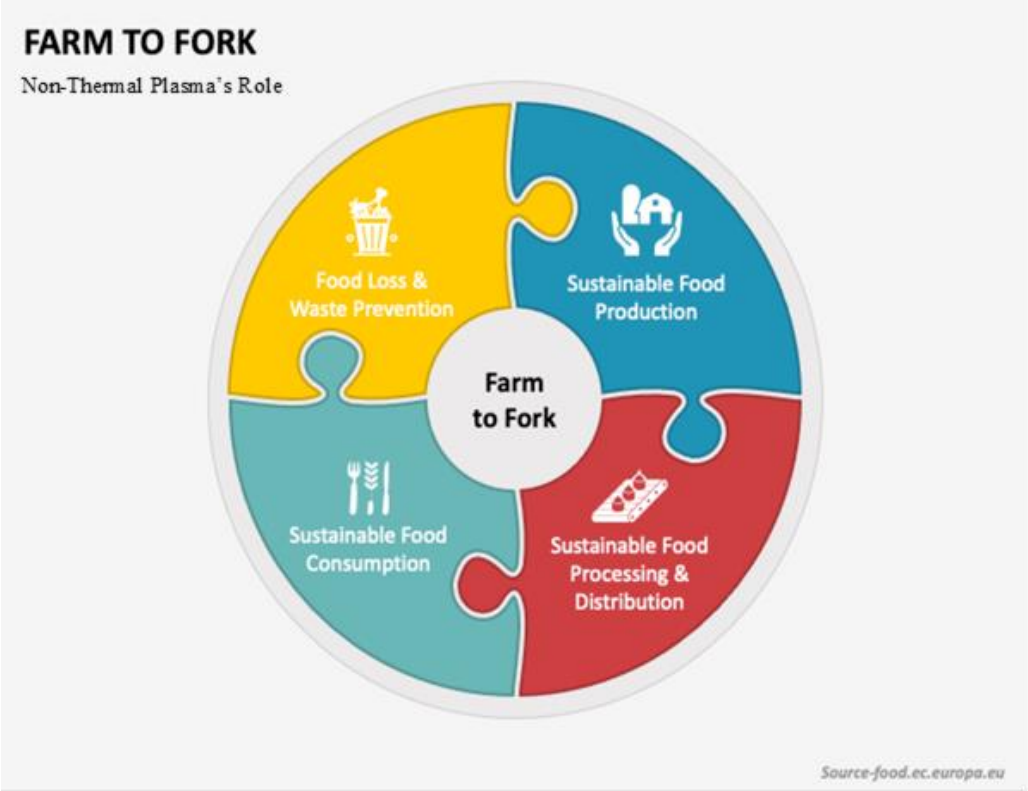


Figure 2. The Benefits of Non-Thermal Plasma Throughout the Halal Food Chain

The implementation of non-thermal plasma sterilization processes (NTSP) throughout the entire halal food production chain from slaughter to processing, packaging, and transportation—can significantly enhance food safety and hygiene. This technology's integration supports strategic objectives in food biosecurity, which are crucial for creating inclusive and efficient agri-food systems. Here's how NTSP aligns with these goals and halal regulations fulfilling many aspects of halal requirements.

NTSP effectively addresses common food safety issues by eliminating pathogens and reducing spoilage organisms at every step of the food supply chain. Its ability to maintain a high level of disinfection continuously ensures that halal food products are protected against contamination throughout their journey from farm to table.

By providing a stable and consistent disinfection method, NTSP helps in maintaining rigorous hygiene standards required in the halal food industry. This adherence to cleanliness is a critical component of halal regulations, which emphasize the need for purity and sanitation in all aspects of food handling and processing.

NTSP's chemical-free and efficient decontamination process aligns well with halal principles, which prohibit the use of substances harmful to human health and require that all processing and handling methods preserve the integrity and wholesomeness of food. By ensuring that no toxic residues contaminate the food products, NTSP supports the stringent compliance requirements of halal certification. (9)

The implementation of NTSP can lead to safer food supply chains, reducing foodborne illnesses and increasing the overall quality of food products. This contributes to more inclusive agri-food systems by enhancing consumer trust and accessibility to safe, high-quality halal food products, thus supporting food security and public health.

NTSP's role in ensuring continuous and effective disinfection directly contributes to the strategic objective of food biosecurity, which is to prevent, control, and mitigate risks to food safety from farm to fork. By enabling safer and more efficient food handling and processing practices, NTSP helps in achieving these objectives. (9)

Overall, the adoption of NTSP in the halal food industry not only ensures compliance with specific halal regulations but also significantly contributes to broader goals of enhancing food safety, supporting sustainable practices, and

promoting public health and food security. This makes it an integral technology for modernizing and improving food production systems.

Regulations and Guidance

Government

There are many common standards and recommendations for sanitary design developed by government and industry organizations. Outside the United States, laws and regulations that address sanitary design and cleaning and sanitizing practices include Cleaning and Validation Guidelines in Canada (Canada HPFB 2005, Timmerman 2013), Law on Food and Feed and subordinated regulations in Germany (Timmerman 2013, USDA FAS 2015), Regulations and the Machinery Directive in Europe (CEN 2009, Timmerman 2013), and the Codex Alimentarius, which provides voluntary international sanitation standards (FAO 2003, Timmerman 2013). In the U.S., the Department of Agriculture (USDA) Food Safety & Inspection Service (FSIS; USDA FSIS 2016) provides guidelines for equipment used in meat, poultry, and egg product facilities. The USDA Agricultural Marketing Service (AMS) (USDA AMS 2016) also has an approval process for dairy equipment. The Food and Drug Administration (FDA) addresses equipment fabrication and cleanability in its Current Good Manufacturing Practice in Manufacturing, Packaging, and Holding Human Food (cGMPs) (21 CFR Part 110). As directed in the Food Safety Modernization Act of 2011, GMP standards will be updated in 2018 through the recent Current Good Manufacturing Practice, Hazard Analysis, and Risk-Based Preventive. Controls for Human Foods regulation (21 CFR Part 117).

Halal Regulations

The halal dietary laws determine which foods are "lawful" or permitted for Muslims. These laws are found in the Quran and in the Sunna, the practice of the Prophet Muhammad, as recorded in the books of Hadith, the Traditions. Islamic law is referred to as Shari'ah and has been interpreted by Muslim scholars over the years. The basic principles of the Islamic laws remain definite and unaltered. However, their interpretation and application may change according to the time, place, and circumstances. Besides the 2 basic sources of Islamic law, Quran and the Sunna, two other sources of jurisprudence are used in determining the permissibility of food, when a contemporary situation not explicitly covered by the first two basic sources. The first is Ijma, meaning a consensus of legal opinion. The second is Qiyas, meaning reasoning by analogy. In the latter case, the process of Ijtihad, or exerting oneself fully to derive and answer to the problem, is used.

Non-government organizations

Nongovernmental organizations, including 3-A Sanitary Standards Inc. (3-A SS) (3-A Sanitary Standards 2016), European Hygienic Design Group (EHEDG) (EHEDG 2004), and National Sanitation Foundation (NSF) (NSF 2016) International have also established standards and recommendations that stress the importance of hygienic design and sanitation practices (Schmidt and Erickson 2005). 3-A SS was originally developed for use in the dairy and egg industries (Schmidt 2013). 3-A SS works with other industry groups to improve standards, and they are active in training, workshops, and sharing knowledge. They provide assurance by conducting on-site evaluations of equipment based on general principles of hygienic design, construction, fabrication, installation, operation, and maintenance (3-A Sanitary Standards 2016, Schmidt 2013).

The European Hygienic Design Group (EHDG) is a consortium of equipment manufacturers, food industries, research institutes, and public health authorities that provide standards for processing equipment construction and design, (EHDG 2004). The group provides technical support for European legislation that requires that handling, preparation, processing, and packaging of food be done using hygienic machinery and in hygienic premises (CEN 2009and ISO 2012). EHDG guidelines include accepted materials of construction, instructions for construction of equipment, functional requirements for the prevention of microbial harborage sites and pathogen growth, and instructions for validating the effectiveness of hygienic design of equipment. The organization also performs validation testing on equipment to evaluate

cleanability (EHEDG 2004, Schmidt and Erickson 2005, Timmerman 2013). The cleaning validation standards under EHEDG stress finding a balance between theoretically proven methods and practical realization of those methods (Timmerman 2013).

The National Sanitation Foundation (NSF) is involved in developing standards for equipment used in food service and retail worldwide. They have also developed general standards for food processing equipment, and have worked with 3-A SS to develop specific standards for equipment used in meat and poultry processing. NSF also provides a variety of certification, auditing, and training programs (Schmidt and Erickson 2005, Schmidt 2013).

Figure 3. Global Food Safety Certifications

The greatest impact of Non-Thermal Plasma (NTP) technology extends beyond just the technical capabilities in food safety and biosecurity—it also plays a critical role in shaping international standards, agreements, and voluntary policies. When these technologies are integrated into organizational outputs, they can significantly enhance global trade and market access for countries. NTP contributes in many ways to affect policies, standards and practices at all levels of international governments.

By demonstrating the efficacy and safety of NTP technologies in the food processing and preservation sectors, organizations can formulate international standards that encourage their adoption. These standards can help harmonize methods and practices across borders, ensuring that food products meet safety and quality benchmarks globally.

NTP's ability to improve food safety and extend shelf life can be a key factor in trade agreements. Countries that adopt NTP technologies can ensure their food products are less likely to be rejected on the grounds of safety concerns, thus facilitating smoother trade relations and access to international markets.

Organizations might develop voluntary policies that promote the use of environmentally friendly and sustainable technologies like NTP. Adoption of such policies can enhance a country's reputation as a responsible trade partner committed to sustainable practices and high safety standards.

By aligning with international standards and agreements facilitated by NTP technology, countries can improve their market access. This is particularly significant for developing countries, which can leverage such technologies

to boost their compliance with global food safety norms and penetrate more competitive markets.
The integration of NTP technology can also lead to the development of better regulatory frameworks that support innovation and safety in food processing. This helps countries ensure that their food products are not only safe but also competitive in the international marketplace.
As more countries recognize the benefits of NTP in meeting international standards, it can drive wider adoption and spur further innovations in food safety technologies. This can lead to a virtuous cycle of improvement, adoption, and standardization, pushing the entire industry towards higher safety and quality standards.
By aligning the capabilities of NTP technology with organizational outputs like international standards and policies, countries can not only enhance their domestic food safety measures but also significantly improve their participation in global food markets. This strategic approach helps in achieving broader economic and health objectives at the international level.
Aligning Non-Thermal Plasma (NTP) technology with organizational inputs such as international standards and technical procedures significantly enhances food safety, quality, and phytosanitary health. This alignment facilitates the creation and revision of standards that are crucial for global trade and public health. Here's a breakdown of how this process contributes to international harmonization:

Research Focus on Non-Thermal Plasma Role in Food Safety, Halal and Tayyib

Non-thermal plasma (NTP) or atmospheric cold plasma (ACP) technology significantly enhances various aspects of food processing and handling through multiple beneficial mechanisms. Research focuses on the ability for NTP to improve processes across different stages due to its versatility in breadth of applications.

NTP and ACP are highly effective at inactivating a broad range of pathogens, including bacteria, viruses, and fungi. This capability is crucial for ensuring the microbiological safety of food products from processing through to packaging and storage.
The ability to apply these plasmas directly to food products without damaging them or altering their nutritional and sensory qualities is a significant advantage. For instance, treating fruits and vegetables with plasma can reduce microbial load while maintaining freshness.
In food processing environments, maintaining clean air is essential to prevent airborne contamination of products. NTP and ACP can be used to treat air, removing pathogens and volatile organic compounds (VOCs), thus improving the overall quality of the indoor environment.
NTP and ACP can be used to produce plasma activated water, which possesses antimicrobial properties. PAW can be used for washing food products, cleaning surfaces, and even as part of the processing steps, enhancing the microbial safety of the process without the use of harsh chemicals. (11)
Beyond ensuring safety, the reduction of microbial load by NTP and ACP can also improve the shelf life and quality of food products. This is particularly important in industries where the spoilage of products can lead to significant economic losses.

The integration of NTP and ACP technologies into food processing and handling not only addresses safety concerns but also contributes to sustainability by reducing the need for chemical sanitizers and preservatives. This aligns well with modern consumer preferences for more natural products and environmentally friendly manufacturing practices. Overall, NTP and ACP offer comprehensive benefits that can significantly enhance the efficiency, safety, and quality of food production processes.

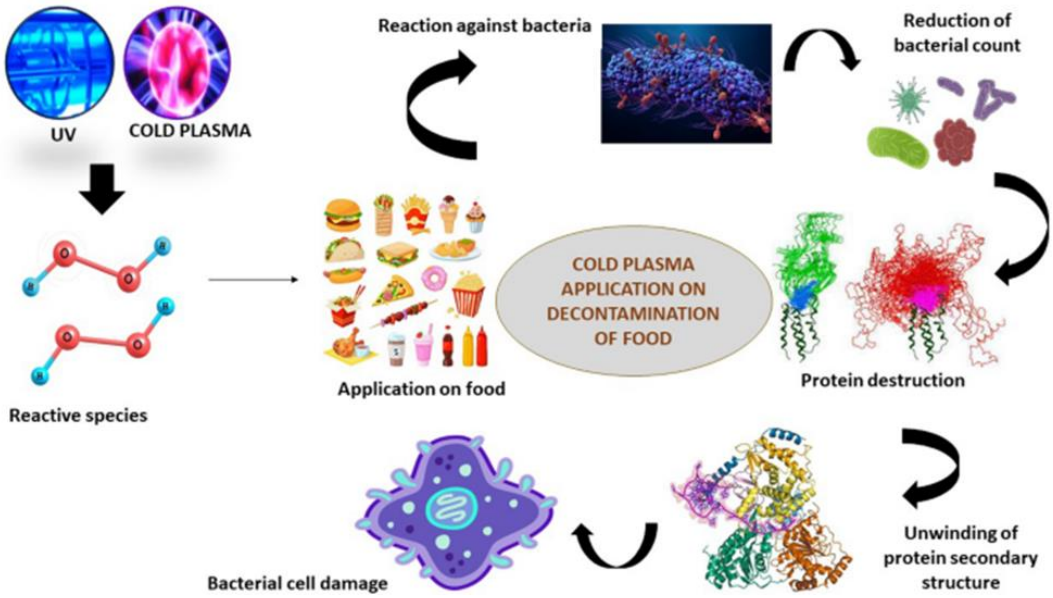
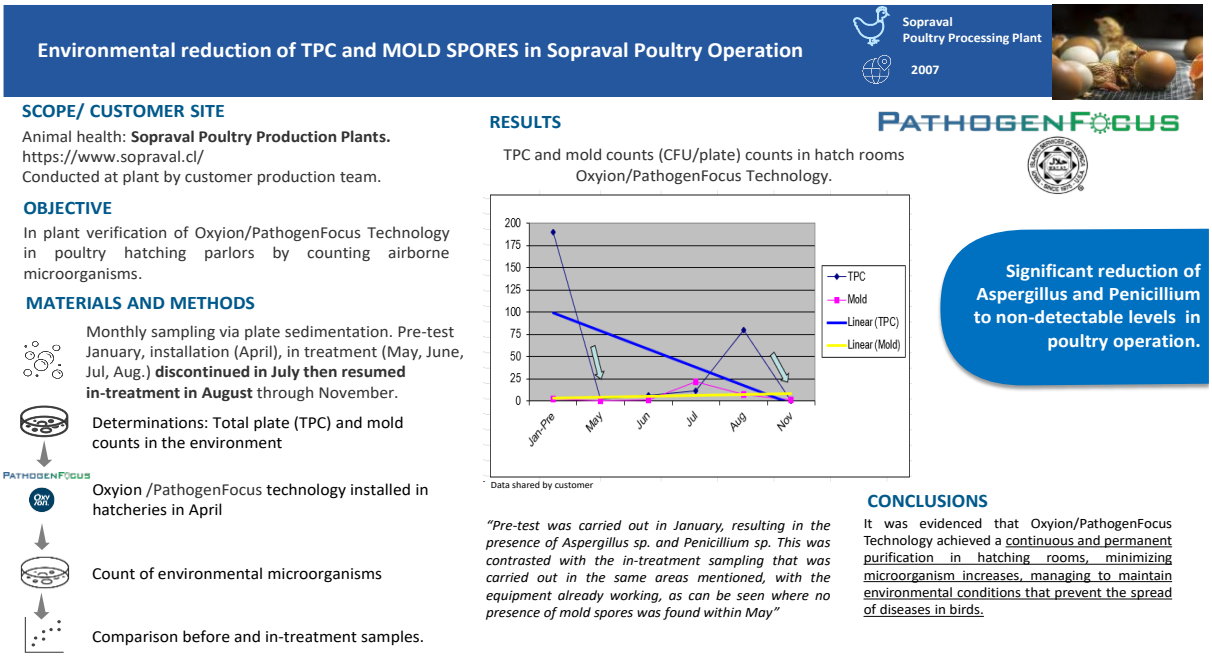


Figure 4. Cold plasma treatment advancements in food processing and impact on the physiochemical characteristics of food products (Farooq, S., Dar, A.H., Dash, K.K. et al. Food Sci Biotechnol 32, 621–638 (2023). https://doi.org/10.1007/s10068-023-01266-5)

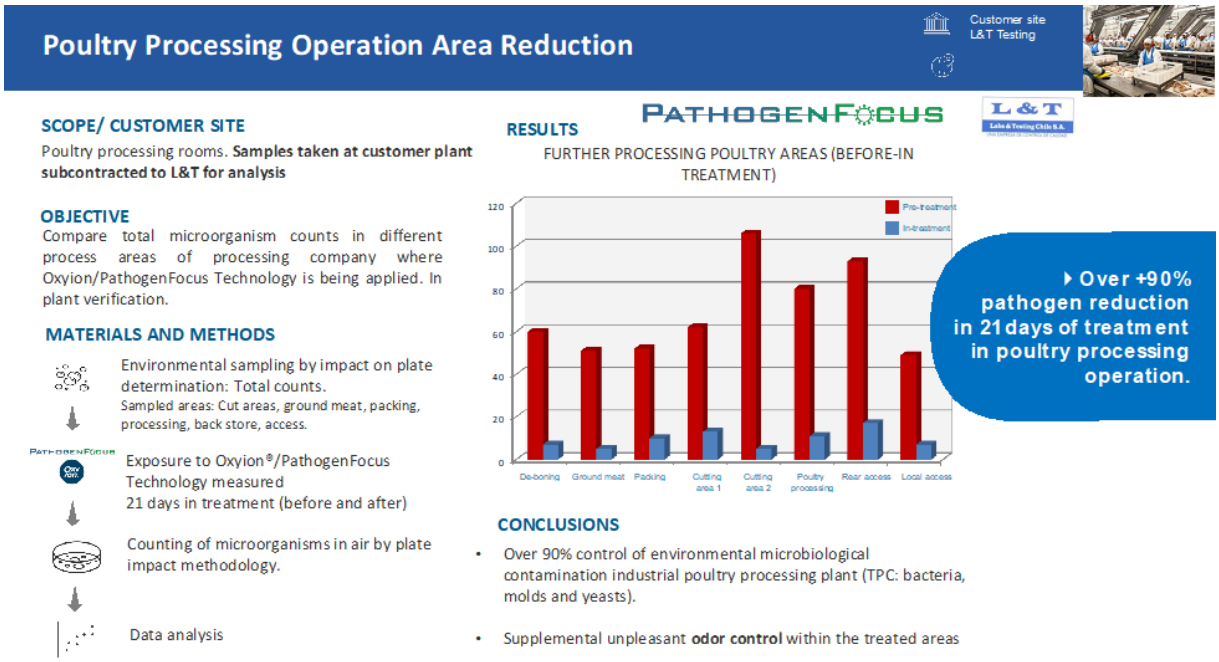
The USDA's exploration into using NTP and ACP technologies to enhance the shelf life of produce could lead to significant improvements in food safety, waste reduction, and economic efficiency within the agricultural sector. Continued research and development in this area may pave the way for wider adoption across the industry, benefiting both producers and consumers by providing fresher, safer, and more sustainable food options.

Case Study Results

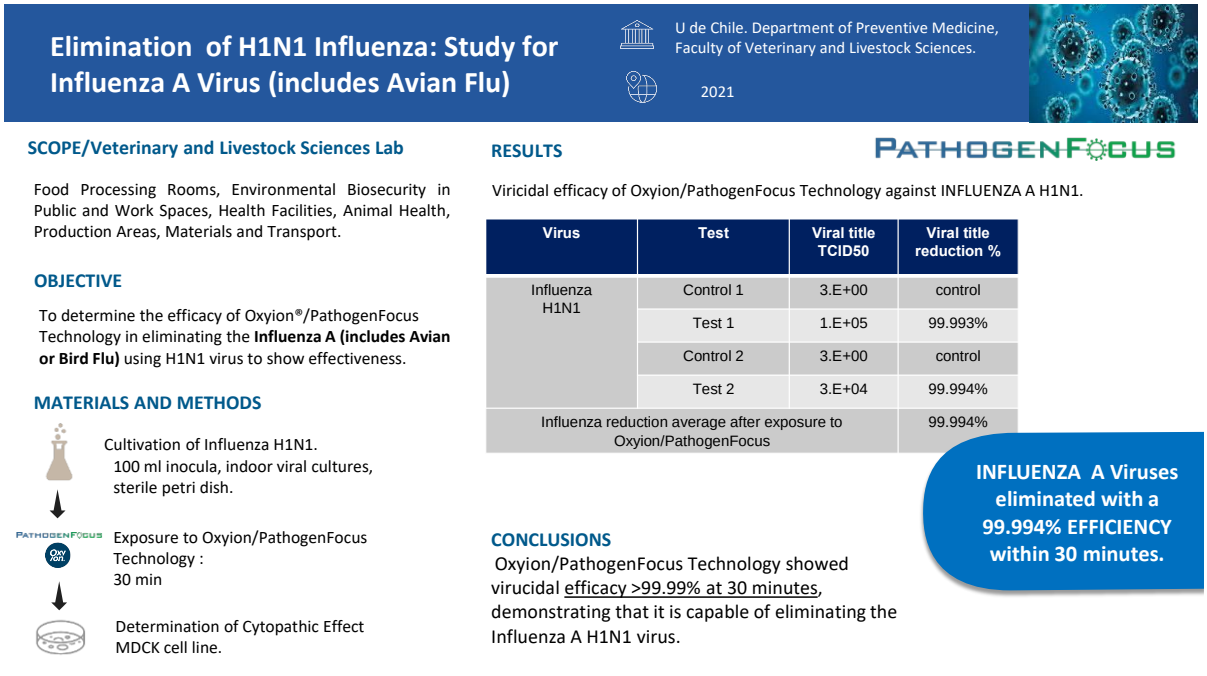
This was a study conducted "in-situ." The site director stated he was having issues with mold in the hatch rooms. Air and surface samples were taken in January. The NTP solution was application engineered based upon the sampling results.



The NTP device was installed in late April. The treatment period was established to take 1 month for the impact and effectiveness to be noted. To ensure that the device was indeed making this significant of an improvement, he turned off the device in July. The CFU counts dramatically increased. He turned on the device again in late August and noted the results previously achieved when the device was activated replicated. The result was this company implementing NTP across their poultry facilities throughout South America.



Another poultry facility was challenged by microbials throughout the processing facility. In-situ sampling was completed and a third-party lab completed the analysis. After application engineering based upon the pretreatment results, the appropriate number of NYTP devices were installed. After 21 days of utilizing NTP continuously for 21 days, a significant reduction in the microbials were noted. As the device continued being utilized the reduction continued to increase.



This was conducted in a lab setting. A major concern in the poultry industry is Avian Flu Virus. NTP effectively reduces the likelihood of transmission of the disease. This demonstrated how NTP plays a critical role in virus reduction in farms and food processing facilities.

Conclusion

The integration of non-thermal plasma (NTP) or cold atmospheric plasma (ACP) into the production and processing of halal food products holds significant potential, with the USDA highlighting ongoing developments and possible improvements. The advancements and recommend future research by the USDA clearly show how NTP can be beneficial for the halal food industry.

NTP and ACP are effective at reducing microbial contamination on food surfaces, including pathogens that are common concerns in halal food processing. This aligns well with the stringent cleanliness requirements of halal standards, helping to ensure that food products are safe and pure as per Islamic law.

Given that halal standards prohibit the use of substances that are harmful or impure, the chemical-free nature of NTP and ACP makes these technologies especially attractive. They provide a way to disinfect and preserve food without introducing any foreign chemicals or residues, maintaining the natural integrity of the food.

Unlike some traditional preservation methods that can affect the taste, texture, or nutritional value of food (such as irradiation or chemical preservatives), NTP and ACP treat foods without high heat or chemicals. This preserves the food's original qualities, which is crucial for consumer acceptance and compliance with halal certification.

NTP and ACP are energy-efficient and environmentally friendly technologies. This sustainability aspect is increasingly important as consumers and regulatory bodies alike are pushing for more eco-friendly practices in all industries, including food production.

NTP and ACP can also be used in innovative packaging solutions that extend the shelf life of perishable goods without the need for preservatives. For example, incorporating plasma-treated materials in packaging can help keep food fresh longer by continuously controlling microbial growth.

By integrating NTP and ACP technologies, halal food producers can not only meet but exceed current standards, potentially opening up new markets where stringent food safety and quality are prioritized. This could give them a competitive edge in both domestic and international markets.

As these technologies become more integrated into halal food processing, they can also influence the development of new halal standards and regulations, particularly around modern and innovative methods of maintaining food safety and quality.

The USDA's focus on enhancing these technologies signifies a promising future for their application in halal food production. As research continues and these technologies are further refined, they could become a standard part of halal food processing, offering benefits from farm to table.

RECOMMENDATION

There is a continuing need for effective antimicrobial processes suitable for application to fresh and fresh-cut fruits, vegetables, meat and other food products, It

is anticipated that cold plasma, in all its many forms, will be a cornerstone technology in that effort. As it matures, it will prove to be one of the most important technologies of the last several decades to arise for application to these commodities. The rapidly expanding body of cold plasma research, academic and industrial, is on pace to support a sea change in how fresh produce is cleaned and preserved in the coming decades.

Think about a challenging situation concerning how to ensure proper hygiene and sanitation in your facilities. Whether it be in air, surface or water NTP offers a potential solution.

Treating the air also impacts surfaces that the air contacts. For water NTP can offer stability p maintenance as well as maintenance reducing microbials and biofilms.

Further work is needed for food dielectric properties, what is the efficiency and how should be the process of plasma flow, contact time, surface effects, commodity shape and contact surface features, for a constellation of antimicrobial processes.

Further work is needed for DNA dissociation of Non-Halal traces in all surfaces or protein of Non-Halal animal, in the slaughterhouse, in the process of preparing halal food.

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HALAL HIGIJENA I SANITACIJA

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Stručni rad

SAŽETAK

Danas, zahvaljujući napretku u netermalnoj plazmi (NTP) ili atmosferskoj hladnoj plazmi (ACP), halal industrija može doživjeti značajno poboljšanje u svojim standardnim operativnim procedurama za dezinfekciju i dekontaminaciju zraka, površine i vode.
Pružanje kontinuiranog, prodornog, stabilnog i dosljednog nivoa biosigurnosti dodatno osigurava prevenciju i smanjenje štetnih hlapljivih organskih spojeva i mikroba u cijelom lancu opskrbe hranom. Dokazano protiv najčešćih pitanja sigurnosti hrane, od klanja do obrade, pakiranja i transporta, halal prehrambeni proizvodi sada mogu doživjeti najbolju moguću dezinfekciju i higijenu. Ove aktivnosti će direktno doprinijeti postizanju strateškog cilja biosigurnosti hrane, koji ima za cilj da omogući inkluzivne i efikasne poljoprivredno-prehrambene sisteme i u određenim aspektima je u skladu sa Halal uredbom. Ovo se dešava kroz organizacioni rezultat: međunarodni standardi, sporazumi i dobrovoljne politike formulisane da poboljšaju pristup zemalja i funkcionisanje međunarodnim tržištima. Kroz izdanje, nove i revidirane međunarodne standarde i nove tehničke procedure za sigurnost hrane, kvalitet i fitosanitarno zdravlje su formulisane i dogovorene od strane zemalja, služeći kao referenca za međunarodnu harmonizaciju.
Upotreba NTP ili ACP poboljšava sve procese kroz njegovu sposobnost da brzo neutrališe mikrobe, utiče na stvarni proizvod u procesu, poboljšava kvalitet vazduha u zatvorenom prostoru, obezbeđuje vodu aktiviranu plazmom i neutrališe mikrobe koji mogu uticati na kvalitet proizvoda. Najnovije područje istraživanja Ministarstva poljoprivrede Sjedinjenih Država (USDA) je korištenje NTP ili ACP za poboljšanje roka trajanja proizvoda. Zbog organske prirode dezinficijensa proizvedenog u plazma komori, utvrđeno je da proizvod ne trpi nikakve fizičke ili nutritivne promjene koje mogu nastati zračenjem. Tokom ove sesije naučit ćete o opsežnim prednostima i tekućim razvojima i poboljšanjima za koja USDA kaže da su moguća za korištenje netermalne plazme ili hladne atmosferske plazme za integraciju ove tehnologije u halal prehrambene proizvode.

Ključne riječi: *Higijena, Halal, Netermalna plazma, atmosferska hladna plazma.*

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