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Halal Standards Around the Globe: A Comparative Study

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A B S T R A C T

Halal food standards refer to the set of dietary guidelines and regulations for Muslims that govern the preparation, handling, and consumption of food. These standards have been published by various countries and organizations worldwide, leading to a diverse range of Halal standards. The varying publication of Halal standards by different countries has posed a challenge for the industry to comply with a unified standard, resulting in a complex and inconsistent landscape. This study aims to compare and analyze the major Halal standards used worldwide, including MS 1500 from Malaysia, GSO 2055-1 from the Gulf Cooperation Council, HAS 23000 from Indonesia, MUIS HC S001 from Singapore, and OIC/SMIIC 1 from the Organization of the Islamic Cooperation (OIC). This study will compare various aspects of the major Halal standards including, but not limited to, methods used for animals stunning, mechanical slaughtering, slaughtering by the peoples of the book, alcohol usage and concentration, insects and their by-products, and vinegar processing. The results of this study will provide a better understanding of the differences in Halal standards and their impact on the global Halal industry. This study is expected to help stakeholders understand these standards and contribute to the development of harmonized Halal standards in the future.

1. Introduction

Halal is an Arabic term that generally refers to permitted items and actions. It is the opposite of Haram, which denotes that which is forbidden. In a broader sense, Muslims attach immense significance to the concept of Halal (Benzertiha et al., 2018; Khattak et al., 2011). It outlines the way of life they must adopt in accordance with the Islamic principles that every Muslim must observe. In a restricted context, one can refer to the Halal industry, which is frequently misinterpreted as relating solely to food and ritual slaughter. In addition to culinary products, the Halal industry includes tourism (including the hotel and service industries), banking, cosmetics, and pharmaceuticals. Muslims currently constitute more than one-third of the world's population (Rezai et al., 2007).
According to Islamic dietary law, Halal food is a food that satisfies the requirements of Islamic dietary law as specified by the Quran and Sunnah. Halal food consumption is not only a religious necessity but also a matter of ethics and food safety. Due to the increasing demand for Halal products among Muslim consumers, the issue of Halal food has become of interest to the food industry. According to Islamic law, Halal meat is obtained from Halalanimals slaughtered in a specific manner (Regenstein et al., 2007).

Halal food is consumed by both Muslims and

non-Muslims due to its perceived high quality and ethical standards (Benzertiha et al., 2018). Nooh et al., (2007) found that younger Muslims know more about Halal cuisine and its certification process. In the Muslim community, Halal cuisine has significant cultural and social significance. It is a crucial component of Islamic identity and a means of preserving their religious beliefs and practices. Halal food also plays a significant role in social gatherings, where food brings people together.

Halal certification guarantees that the food and its ingredients comply with Halal standards. Halal food consumption is not limited to Muslims, and its global market is expanding significantly. The certification procedure includes an evaluation of the production method, ingredients, and storage and transport of the product. Halal certification is typically administered by government-recognized Islamic organizations or by independent Halal certification bodies. Each country has its Halal certification bodies, which are in charge of issuing Halal certificates (Lutfika et al., 2022).

Halal certification bodies are responsible for ensuring that products and services meet the Islamic dietary requirements, as set out by the Halal standards. These standards are typically published by a government authority of a specific country, and Halal certification bodies use them as a reference to certify the Halal status of products. However, the existence of multiple Halal standards around the world can create confusion among food manufacturers who operate in different markets. These differences can include variations in the Halal certification process, permitted ingredients, and slaughter practices, among others (Abdallah et al., 2021).

In recent years, the Halal market, which encompasses a vast multitude of products and services permitted by Islamic law, has experienced rapid growth. From food and beverages to finance and tourism, the global Halal market is estimated to be worth trillions of dollars, with this value expected to rise as the Muslim population grows and more consumers seek out Halal products (Dinar Standard, 2022).

According to the Dinar Standard report (2022), the world's 1.9 billion Muslims spent the equivalent of $2 trillion in 2021 in food, pharmaceutical, cosmetics, fashion, travel, and media/recreation industries, all of which are influenced by ethical consumption requirements inspired by the Islamic faith. Assets related to Islamic finance are projected byan increaseof7.8% from US$3.4 trillion in 2020 to US$3.6 trillion in 2021, representing an annual growth rate of 8.2% (Dinar Standard, 2022).

Table 1. Total spending and growth of the Halal economy *(Dinar Standard, 2022)*

Category	2021 Spend (US$ billion)	Expected Growth in 2022	Expected Spend in 2025 (US$ billion)
Food and Beverages	1.270	7.00%	1.670
Halal Finance	3,600	8.00%	4,900
Halal Tourism	102	50.00%	189
Modest Fashion	295	6.00%	375
Pharmaceuticals	100	6.70%	129
Halal Cosmetics and Personal Care	70	7.20%	93
Media Sector	231	7.50%	308
Investments	25.7	-	-

Despite the ongoing uncertainty associated with the pandemic situation, it is anticipated that global Muslim spending will increase by 9.1% in 2022, excluding the Islamic finance sector, for the Islamic economy sectors covered in this report. By the end of 2021, with the exception of travel, all of these sectors have returned to their pre-pandemic expenditure levels. At a Cumulative Annual Growth Rate (CAGR) of 7.5% over the next four years, Muslim spending is expected to reach $2.8 trillion by 2025 (Dinar Standard, 2022). With the growing demand for Halal products, there has been an increasing interest in understanding the various Halal standards and certification systems that are used across different countries. This comparative study aims to examine the various Halal standards and certification systems used in different countries and to compare their similarities and differences. The study will provide valuable insights into the current state of Halal standards and certification, as well as highlight areas for improvement and future development. The results of this study will be of interest to scholars, researchers, policymakers, and industry stakeholders who are concerned with the development and growth of the Halal industry.

2. Halal standard

Halal food standards is a set of requirements that have to be compliance with Islamic rules in order to have Halal certified products. Nonetheless, there are numerous distinct Halal standards, each with its own set of rules and requirements with minor differences. Multiple

Halal standards are recognized and implemented by various countries and organizations, including MS 1500, GSO/UAE.S 2055.1, HAS 23000, MUIS HC S001, and OIC/SMIIC 1.

MS 1500 is a Malaysian government-issued standard addresses all aspects of Halal certification, including processing, handling, and packaging of Halal products. It also incorporates animal welfare and Halal slaughtering guidelines. Halal certification organizations use MS1500 as a point of reference in Southeast Asia. It includes hygiene, packaging, storage, and transportation requirements for Halal food products (DSM, 2019).

GSO/UAE.S 2055.1 is a Halal standard issued by the Gulf Cooperation Council (GCC) and the UAE, covers the entire food supply chain, from farm to table. It includes guidelines for Halal slaughtering, animal welfare, and the use of Halal ingredients. This standard also covers the labeling and marketing of Halal products (GSO, 2015a).

HAS 23000 is the Indonesian Halal certification standard developed by the Indonesian Council of Ulama (MUI) and covers the entire food supply chain, from farm to table. Guidelines for Halal slaughtering, animal welfare, and the use of Halal ingredients. HAS 2300 also covers the labeling and marketing of Halal products.

It also includes guidelines for the sourcing of raw materials, processing, and labeling of Halal food products (LPPOM MUI, 2021).

MUIS HC S001 is a standard developed by the Majlis Ugama Islam Singapura (MUIS) in Singapore. It includes guidelines for the sourcing of raw materials, processing, and labeling of Halal food products, and covers other areas such as food additives, enzymes, and flavorings (MUIS, 2005).

The Organization of Islamic Cooperation (OIC) and the Standards and Metrology Institute for the Islamic Countries (SMIIC) have developed a Halal standard (OIC/SMIIC 1) that is intended to be used globally. The standard covers all aspects of the Halal food supply chain and includes guidelines for the sourcing of raw materials, processing, and labeling of Halal food products (OIC/SMIIC, 2019).

3. Production plant and its cleaning

Despite the fact that the basic requirements for Halal food production are similar, there are differences, particularly in the specific standards and requirements that need to be followed. In this chapter, the similarities and discrepancies in term of the condition of the production plant and its cleaning procedures are summarized in the **Error! Reference source not found.**.

Table 2. The requirements of the production plant and its cleaning procedure in various Halal standards

Requirements	**MS 1500** (DSM, 2019)	**GSO/UAE.S 2055 .1** (GSO, 2018)	**HAS 23000** (LPPOM MUI, 2021)	**MUIS HC S001** (MUIS, 2005)	**OIC/SMIIC 1** (OIC/SMIIC, 2019)
Halal product must be separated from non-Halal products	✓	✓	✓	✓	✓
All Halal products must be Halal labelled to be easily segregated	✓	✓	not mandatory	✓	✓
General cleaning is a must when transforming from non-Halal to Halal production	✓	✓	✓	✓	✓
Soil must be used to clean heavy *najis*	✓	not required	not required	✓	✓
Shifting from non-Halal to Halal production is not allowed in regular basis	✓	✓	allowed if it is pork free	✓	✓
Chemical agents including cleaning substances, greases or fats shall not contain non-Halal materials	✓	✓	✓	✓	✓
Hygiene, sanitary and food safety are prerequisites in the Halal food production	✓	✓	✓	✓	✓
The production facility must be segregated and well insulated from pig farm or its processing	✓	✓	✓	✓	✓
Pest control program must be implemented	✓	not stipulated	not stipulated	not stipulated	not stipulated
Tools or elements of religious worship are not allowed in the production facility	✓	not stipulated	not stipulated	not stipulated	not stipulated
Muslim praying room must be available	✓	not stipulated	not stipulated	not stipulated	not stipulated

All standards compared in this study mentioned that separating Halal products with non-Halal

products is necessary to avoid cross contamination. In order to increase the effectivity of the separation during storage and transportation, most standards oblige to mark the product with Halal label. However, HAS 23000 does not make this action mandatory as long as it can be separated, and cross contamination can be avoided. Additionally, all standards agreed that the production facility must be segregated and well insulated from pig farm or its processing.

At a similar tone, all of the standards require general cleaning when transforming from non-Halal to Halal production. This transformation is a solution for the company that opts into Halal production without new equipment and facilities installation. Generally, shifting from non-Halal to Halal production is not allowed on a regular basis. Consequently, MS 1500, MUIS HC S001, GSO/UAE.S 2055.1, and OIC/SMIIC 1 stipulate that the facilities must be Halal dedicated. While HAS 23000 permits to use of the facilities interchangeably with non-Halal production with the condition that pork and its derivatives are not used in the shared facilities.

Furthermore, these standards agreed that there are three types of *najis* (impurities) that shall be cleaned before Halal production. Heavy *najis* are the things from swine and pork. Intermediate *najis*are blood, vomits, vaginal, anal and penile discharge and from other parts of a human and animal body. Light *najis* is the urine of a baby boy under two years old who consumed his mother's milk exclusively.

The way of purification on intermediate and light *najis* is similar from one to another standard. Both types of these *najis* can be easily purified by removing the *najis* and washing the contaminated area using water. Whereas heavy *najis* must be cleaned by washing them seven times using water and one of them using a mixture of water and soil. MS 1900, MUIS HC S001 and OIC/SMIIC 1 stipulate that soil must be used to purify the heavy *najis*. On the contrary, GSO/UAE.S 2055.1 and HAS 23000 allow using soil, soap, detergent or any chemicals that can remove the odor and color of the *najis*. Additionally, concerning the cleaning procedures requirements, all the countries require chemical agents, including cleaning substances, greases or fats free from non-Halal materials.

In addition, hygiene, sanitary and food safety are the pre-requirement in Halal food production. This requirement ensures that Halal food production is safe for human consumption. Generally, the basic requirement of every food production is food safety. Halal is the added value food products can have so that Muslims can consume them. Although all the standards mention that hygiene and sanitary are the prerequisites of Halal food production, only MS 1500 explicitly requires the implementation of the pest control program.

Another difference is related to the Muslim praying room and tools of religious worship. Even though most of the standards do not require, MS 1500 obliges the manufacturer to have a Muslim praying room in the production plant facility. Simultaneously, MS 1500 forbid any tools or elements of religious worship other than Muslim.

4. Animal slaughtering

Animal slaughtering is one of the key elements of the Halal requirement for meat which shall be fulfilled(Bozzo et al., 2020). Generally, food is originally either from plants or animals. Plant-origin material is naturally Halal unless it has intoxicating properties. This definition excludes any alcoholic beverages and any plants that by its origin, possess intoxicating agents such as marijuana, cocaine or heroin (Mehra et al., 2019).

On the other hand, all amphibious animal is considered unlawful. In the middle of that, there are land animals that, by their origin, are not Halal unless it fulfills two requirements:1) Classified as Halal animals such as cow, goat/sheep, or poultry, 2) they are appropriately slaughtered according to Islamic Law (Jalil et al., 2019). All the standards agreed about the type of animal that Muslims can consume. However, there are some specific differences in the standards regarding slaughtering. These differences generate problems in determining which meat is Halal and which is not. For instance, according to GSO/UAE.S 993, an animal can be slaughtered by either Muslims, Jews or Christians. While HAS 23103, MS 1900 and OIC/SMIIC 1 only allow Muslims. In this case, an animal slaughtered according to the GSO/UAE.S standard might not be suitable to be exported to Indonesia or Malaysia.

The differences may generate confusion, particularly for the manufacturer in a non-majority Muslim country where Halal is unpopular among them. The producer wants to export the product to Islamic countries where Halal is required, but which standards must be

followed is still a question. **Error! Reference source not found.** compares Halal slaughtering requirements among six different Halal standards, Malaysia, UAE.S2022, GSO 2015, Indonesia, Singapore, and OIC/SMIIC. The requirements vary among the standard, with some having stricter requirements than others. Halal

Animal slaughtering is the act or process to kill animals to obtain meat and offal's for human consumption. To slaughter the animal, sticking (neck cutting) is carried out using sharp knife to sever major blood vessels involving the esophagus, two jugular veins and pharynx of the animal ensuring rapid and complete blood loss (Fuseini et al., 2016). Before the slit of the animal, stunning may be used to reduce the animal's mobility animal and ease the slaughtering process. Stunning is a method to make the animals unconscious with or without killing them to improve the efficiency of the slaughtering (Yardimci, 2019). Several studies mentioned that stunning might eliminate the fear or pain in the animal (Abdallah et al., 2021; Abdullah et al., 2019). However, this conclusion is still debatable since many researcher also against it and reported that stunning magnifies animal suffering and stress during slaughtering process (Nakyinsige, Fatimah, et al., 2014; Nakyinsige, Sazili, et al., 2014; Yardimci, 2019).

Table 2. Slaughtering requirements according to various standards

Requirements	**MS 1500** (DSM, 2019)	**UAE.S 993: 2022** (GSO, 2022)	**GSO/UAE.S 993:2015** (GSO, 2015b)	**HAS 23103** (LPPOM MUI, 2012)	**MUIS HC S001** (MUIS, 2005)	**OIC / SMIIC 1** (OIC/SMIIC, 2019)
Stunning is not recommended	not stipulated	✓	✓	not stipulated	not stipulated	✓
Stunning that results in death or heart stop of the animal is strictly forbidden	✓	✓	✓	✓	✓	✓
Stunning must be periodically verified and revied by HCB to ensure that the stunning does not kill the animal	✓	✓	✓	✓	✓	✓
Stunning using penetrative captive bolt, ax/hammer or air blowing and gassing is prohibited	✓	✓	✓	✓	✓	✓
The stunning operator is preferably a Muslim	✓	✗	✗	✗	✓	✗
Stunning on poultry is not permitted	✗	✗	✓	✗	✗	✗
The performance of the stunner must be controlled and verified by qualified and trained personnel	✓	✓	✓	✓	✓	✗
The blood flow of the stunned animal should be monitored, if less than normal amount of blood observed the carcass is treated as non-Halal	✗	✓	✗	✗	✗	✗
Only electrical water batch is permitted for poultry stunning	✓	✓	poultry stunning is prohibited	✓	✓	✓

Table 2. Slaughtering requirements according to various standards

Requirements	**MS 1500** (DSM, 2019)	**UAE.S 993: 2022** (GSO, 2022)	**GSO/UAE.S 993:2015** (GSO, 2015b)	**HAS 23103** (LPPOM MUI, 2012)	**MUIS HC S001** (MUIS, 2005)	**OIC / SMIIC 1** (OIC/SMIIC, 2019)
All the carcasses must be examined to indicate if the animal is dead before slaughtered	✓	✓	✓	✓	✓	✓
The Slaughtermen shall be Muslim	✓	✗	✗	✓	✓	✓
The Slaughtermen can be either Muslim, Jew or Christian	✗	✓	✓	✗	✗	✗
The Slaughtermen shall be minimum 18 years old	✗	✗	✗	✓	✗	✗
The Slaughtermen shall be an adult	✓	✓	✓	✓	✓	✓
The Slaughterman shall be authorized by competent Halal body	✓	✓	✓	✓	✓	✓
Slaughtering shall be done by or under direct actual supervision of the HCB	✗	✗	✓	✗	✗	✓
Mechanical slaughtering is allowed	✓	✓	✓	✓	✓	✓
Mechanical slaughtering can be used if the percentage of mis-cutting is under 1%	✗	✗	✗	✓	✗	✗
The bleeding period of poultry shall be at least 180 seconds	not stipulated	not stipulated	✓	✓	not stipulated	✓
At least two surveillance cameras must be installed in the slaughtering area and the film must be preserved for at least 90 days	✗	recommended	✗	✗	✗	✗

Stunning can be done using various techniques, including electrical stunning, captive bolt stunning, gas stunning or air-blowing stunning (Yardimci, 2019). All Halal standards prohibit stunning using penetrative captive bolt, ax/hammer or air blowing, and gas stunning. However, MS 1500, UAE.S993:2022, HAS 23103, OIC/SMIIC 1 and MUIS HC S001 mentioned that an electrical water bath is an only permitted method for poultry stunning. In contrast, GSO 993:2015 even strictly exclude poultry stunning for Halal food production.

According to common definitions, stunning may result in the animal's death before slaughter. In this case, the carcass is considered as non-Halal. On this basis, the stunning process is not recommended by most standards. Additionally, without any strict control of the stunning process, it cannot be guaranteed that the animal is not killed before slaughtering (Abdallah et al., 2021). Therefore, all standards require the stunning parameter process to be verified and reviewed by the Halal Certification Bodies periodically to ensure that the stunning process does not kill the animals. The parameters of the electrical stunning include but are not limited to

the voltage, current and frequency. Although some standards introduce the range of acceptable parameters for specific animals, these standards also state that the stunning parameter record the animal periodically after the stunning process, whether the animal can gain consciousness after the stunning process. Carcass examination after slaughtering is also required to indicate if the animal is dead before slaughter. UAE.S993:2022 even requires monitoring the blood flow. If it is less than the normal amount of blood observed, it is automatically opted out of Halal product.

According to Islamic law, the animal's death shall be caused by slaughtering solely. Any acts before or after slaughtering that alter the death process of the animal are prohibited. Therefore, any further processing, including scalding / skin removal or evisceration, is not allowed before the animals are dead completely (Yardimci, 2019). To ensure this, GSO/UAE.S 993:2015, HAS 23103 and OIC/SMIIC 1 stipulate the bleeding period of poultry shall be at least 180 seconds. While MS 1500, UAE.S 993:2022 and MUIS HC S001 do not require minimum bleeding time as long as the animal is dead before further processing.

Slitting is the core of the slaughtering process that can be done either by humans or machines. Hand slaughtering is a process of killing animals manually using a knife operated by a human. In contrast, mechanical slaughtering is an automated slaughtering process performed by a machine. All the standards allow both hand and mechanical slaughtering. The last method is acceptable if there are proven that miss-cutting can be avoided, even according to HAS 23103, mechanical slaughtering can be used if the mistake of the slaughtering is below 1%.

One of the major differences in animal slaughtering is the slaughterman. MS 1500, HAS 23103, MUIS HC S001 and OIC/SMIIC 1 stated that the slaughterman must bean adult Muslim, while GSO/UAE.S 993 allows either an adult Muslim, Jew or Christian slaughterers. Additionally, HAS 23103 requires that the slaughterman be at least 18 years old.

5. Alcohol

Alcohol is any carbonic compound that contains one or more hydroxyl functional groups (–OH) connected to a carbon. Ethanol is one of the alcohol organic configurations containing must be adjusted individually according to the condition of the slaughterhouse. To support this, the food manufacturer must examine and

two carbon atoms and one hydroxyl group. Ethanol is a compound that has intoxicating effects,it acts as a central nervous system depressant, an agent which reduces the functionality of the central nervous activity. It leads to slow down the brain responses and causes the feeling of being "drunk." (Pauzi et al., 2019).

From an Islamic perspective, there are two types of ethanol: *khamr* and non-*khamr*. *Khamr* is an Arabic word derived from *khamara*, meaning "to cover". It refers to any intoxicating substances and may cause losing ability to any individuals who consume it (Michalak & Trocki, 2006). By this definition, *khamr* includes all types of alcoholic beverages. Thus, *khamr* ethanol is any ethanol produced through alcoholic beverages fermentation, among others, beer, wine, vodka and whisky. While non-*khamr* ethanol is any ethanol not produced from alcoholic beverages fermentation. This ethanol can be produced by fermentation or synthetically (Mohammad Aizat Jamaludin et al., 2018).

According to Islamic Law, the consumption of alcohol is considered Haram (forbidden). In Islam, consuming alcohol is seen as a sin. It is prohibited as it leads to a loss of consciousness, resulting in a person committing immoral acts, harming themselves or others, and neglecting their religious obligations (Rassool, 2014).All standards agreed that *khamr* ethanol is considered non-Halal regardless of concentration and use. Regarding non-*khamr* ethanol, most standards determine the maximum limit of alcohol allowed in food products, although the permissible concentration varies among the standards. The permitted maximum ethanol concentration in different food products according to different standards, including HAS 2300, MS 1500, GSO 2538 and MUIS HC S001, are illustrated in. OIC/SMIIC has not published any standard determining the maximum limit of permissible ethanol in food products. Its standard is still being created, i.e., OIC/SMIIC CD 38 Maximum Limit for Residues of Ethyl Alcohol (Ethanol) in Food. However, according to OIC/SMIIC 1, Halal products shall not contain alcohol.

Table 3. Permissible alcohol/ethanol limits in various Halal Standards

Criteria	HAS 23000	MS 1500	GSO 2538	MUIS HC S001
Beverages dedicated for *khamr*	Strictly prohibited	Strictly prohibited	Strictly prohibited	Strictly prohibited
Intentionally added non-*khamr* ethanol in food and beverages.	No limit and safe	<0.5%	Not allowed	Not allowed
Non-*khamr* beverages	<0.5%	<1%	<0.1%	0.1%
Unintentional alcohol	End product <0.5% for beverage and no limit for food if it is medically safe.	<1%	Depending on the products, As shown on the Error! Reference source not found.	0.1%
Flavor and colorants	End product <0.5% for beverage and no limit for food if it is medically safe.	End product <0.5%	Depending on the products, As shown on the Error! Reference source not found.	0.5%, end product 0.1%
Fermented dairy (solid/paste)	No limit if it is medically safe	<1%	<0.3%	0.1%
References	(LPPOM MUI, 2021)	(DSM, 2019)	(GSO, 2021)	(MUIS, 2005)

Beverages dedicated for *khamr* are strictly restricted in all four standards, consistent with the Islamic prohibition on consuming alcoholic beverages. The intentionally added non-*khamr* ethanol in food and beverages has different limits across the standards. On the one side, HAS 23000 allows the use of non-*khamr* ethanol without any limit, provided it is considered safe. MS 1500 allows non-*khamr* ethanol in food and beverages but with a less than 0.5% limit. Conversely, GSO 2538 and MUIS HC S001 do not allow any intentionally added ethanol in food and beverages.

The upper limit of permissible ethanol in beverages also has different limits across the standards. HAS 23000 and MS 1500 permit non-*khamr* ethanol in beverages with limits of less than 0.5% and less than 1%, respectively. GSO 2538 and MUIS HC S001 have a lower limit of less than 0.1%.

Furthermore, alcohol could be in the end product even when alcohol is not used during the processing, which is called unintentional alcohol. It pertains to alcohol that may be present in food or beverages due to the manufacturing process or fermentation. HAS 23000 permits a maximum end product limit of less than 0.5% for beverages and no limit for food, provided it is medically safe. MS 1500 allows up to 1% of unintentional alcohol, whereas GSO's permissible limits depend on the product type, as shown in **Error! Reference source not found.**, with some limits as high as 0.5% and others as low as 0.02%. Similarly, MUIS HC S001 has a lower limit of 0.1% for unintentional alcohol.

Table 4. Maximum Limits of Ethyl Alcohol (ethanol) residues in foodstuff according to GSO 2538 *(GSO, 2021)*

Product	**Upper Limit**
Grape vinegar	1% v/v
All vinegar types except grapes vinegar	0.5% v/v
Sauces, ketchup (all kinds), drinks / concentrated juices, concentrates, food mixes prepared for manufacturing, and aromatic herbs oils.	0.5% v/v or v/w
Juices including different types of nectar, cocktails and drinks and ready-to-drink flavored water	0.1% v/v
Fresh or processed foods of meat, milk and grains legumes, oils, eggs, seafood spices and sweets.	0.3% v/v or v/w
raw materials such as protein concentrates, sugars Yeast, essential oils, raw cocoa and other similar raw material	0.5% v/v or v/w
Chocolates	0.02% v/w
Others	0.02% v/v

The flavor and colorants refer to food additives that may contain alcohol/ethanol but are not intended to have an intoxicating effect. HAS 23000 and MS 1500 permit maximum alcohol

content at the end product of less than 0.5%. Despite that, HAS 23000 allows alcohol in flavor without any limit on food, provided that it is medically safe. GSO 2358 allows a limit of less than 0.5% for the end product, with some exceptions, as shown in **Error! Reference source not found.**, where the permissible limit may be as low as 0.1%. MUIS HC S001 has a lower limit of 0.5% for flavor and colorants and a limit of 0.1% for the end product.

Finally, the fermented dairy (solid/paste) category pertains to dairy products undergoing fermentation. HAS 23000 has no limit on the permissible amount of alcohol/ethanol in fermented dairy products if it is medically safe. MS 1500 allows up to 1%, while GSO 2358 and MUIS HC S001 have a limit of less than 0.3% and 0.1%, respectively.

6. Vinegar

Vinegar is a versatile liquid used for centuries for its culinary, medicinal, and household applications. It is a dilute solution of acetic acid produced through the fermentation of ethanol by acetic acid bacteria. Vinegar can be made from various sources, including fruits, grains, and sugarcane, and the resulting flavors and aromas can vary greatly depending on the starting material and the fermentation process used (Singh, 2020).

Vinegar has many uses in cooking, such as flavoring, preserving, and tenderizing foods. It is also used as a natural cleaning agent due to its antimicrobial properties and ability to break down grease and grime. In addition, vinegar has been used for its medicinal properties, including aiding in digestion, reducing inflammation, and promoting weight loss (Kara et al., 2022).

From an Islamic point of view, there are specific guidelines regarding the use of vinegar. For vinegar to be considered Halal, it must be produced from permissible sources and not contain any haram (prohibited) substances. One of the key aspects of Halal vinegar is the process of *istihalah*, which refers to transforming a haram substance into a permissible one through a chemical change. In the case of vinegar, fermentation causes a chemical change in the starting material, converting the alcohol into acetic acid. This transformation is considered a form of *istihalah*, which renders the vinegar Halal and permissible for consumption (Mohammad Aizat Jamaludin et al., 2018).

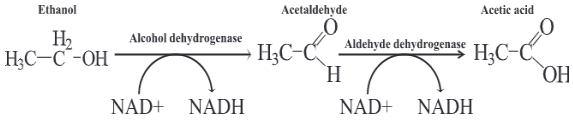

Fig 1. Conversion of ethanol (alcohol) to acetic acid (vinegar) (Jahangir et al., 2016)

Vinegar, as a fermented product, raises concerns regarding its compliance with Islamic dietary laws due to the possibility of alcohol production during the fermentation process. Alcohol, specifically ethanol, is generated through the fermentation of fruits, grains, sugar, or starch in the presence of yeast, and if its concentration is high enough, it may have an intoxicating effect, making it prohibited for Muslims(M. A. Jamaludin et al., 2016). Therefore, Halal food and beverage standards have been established in Muslim countries, setting permissible alcohol content limits.

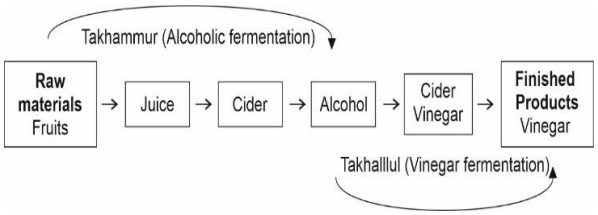

Fig. 2. Fermentation process of takhammur and takhallul (M. A. Jamaludin et al., 2016)

The process of vinegar production involves two stages of fermentation: *takhammur* (winemaking) and *takhallul* (vinegar making). *Takhammur* is an alcoholic transformation from carbohydrate-rich materials through a fermentation process. While *takhallul* is a conversion of alcohol to acetic acid(M. A. Jamaludin et al., 2016).

The critical Halal point of vinegar is the source and the ethanol content. Both requirements must be fulfilled to obtain Halal vinegar. The GSO 2538, MUIS HC S001 and OIC SMIIC 1 forbid any vinegar from alcoholic beverages. Consequently, although the *istihalah* process occurs, vinegar made from wine, beer, whisky and similar beverages is considered non-Halal. In contrast, HAS 23000 and MS 1500 deemed that vinegar from alcoholic beverages is Halal. However, MS 1500 also requires natural fermentation, a fermentation without any additives must occur. Consequently, if any additive is used, vinegar from alcoholic beverages will not be considered as Halal.

Additionally, the permitted ethanol content in vinegar is regulated differently according to several standards and summarized in the Table 5.

Table 5. The critical Halal point of vinegar according to different Halal standards

Halal Standard	Vinegar from *khamr*	Maximum ethanol concentration in vinegar
MS 1500	Halal with natural fermentation	1.0%
GSO 2538	Haram	0.5%, except grape vinegar 1.0%
HAS 23000	Halal	0.5%
MUIS HC S001	Haram	0.1%
OIC/SMIIC 1	Haram	Not determined

7. Insects

Nowadays, the request for more sustainable food in particular proteins and fats have a growing demand worldwide, among the proposed sustainable food resources an increasing interest has been touting insects. The one that is used to treat food waste, require less space, water, and regenerate less gas emissions(Cerritos, 2009; Güneş & Özkan, 2018; Tajudeen, 2020; Van Huis, 2013, 2020; Van Huis & Oonincx, 2017). However, the acceptance of insects as a source of proteins and fats is depending on the region and human culture(Van Huis, 2013).

According to the EU legislations, by adding silkworm (*Bombyx mori*) to the list of the authorized species. Since November 2021, eight insect species are allowed to be reared and processed under certain conditions. Among these insect species, black soldier fly *(Hermetiaillucens*), yellow mealworm (*Tenebrio molitor*) and super mealworm larvae (*Zophobasmorio*) have been predominantly studied as a source of protein, fats and other nutrients, due to their interesting qualitative and quantitative amino-acids, fatty-acids and minerals profiles (Aguilar-Toalá et al., 2022; Benzertiha et al., 2020; de Souza-Vilela et al., 2019; Mwangi et al., 2018; Roos, 2018). Among other insects, lac insect (*Kerria lacca*) is promoted as a source of natural safe resin which is applied in cosmetics, pharmaceuticals, and a surface coating in different industries (Sharma et al., 2020).

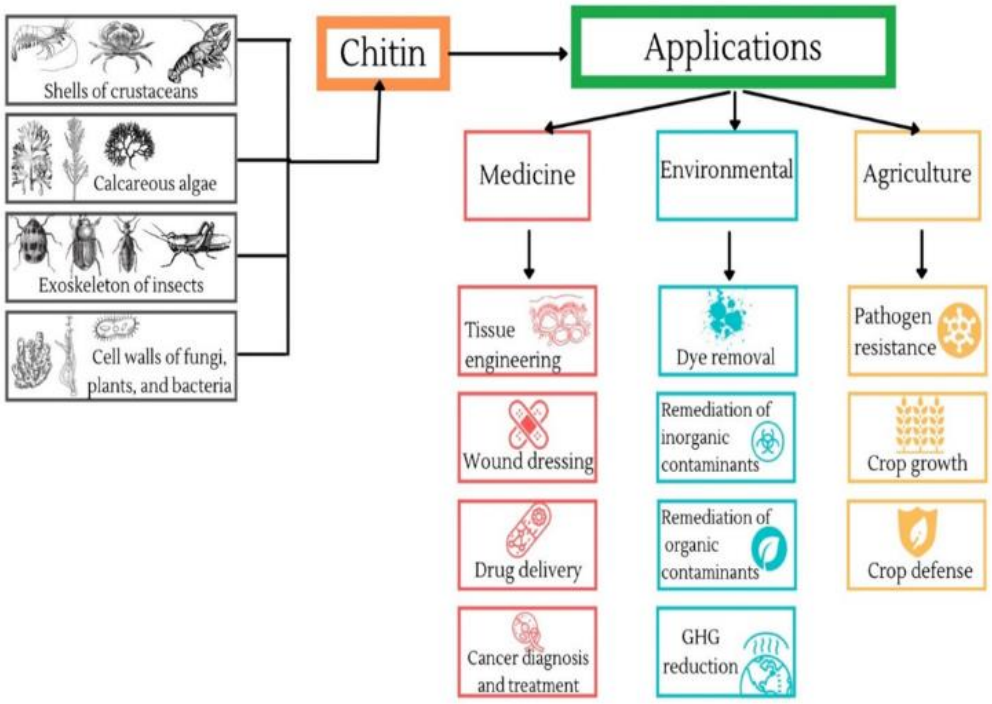

Fig. 3. Different sources of chitin application (Dave et al., 2021)

In addition, silkworm (*Bombyx mori*) is reported to be one of the famous sources of different materials that have a diverse application (Cao et al., 2016). According to Khosropanah et al.,

(2022), silkworm has various biomedical applications. It is reported by the same authors that silk contains fibroin and sericin and has been used to treat various tissues of the human body (bone, skin, nerve...etc.). Furthermore, insects are reported to have high amount of chitin in their exoskeleton(Benzertiha et al., 2020; Finke, 2007; Zhu et al., 2016). According to several authors chitin is widely used in several industries. Because of unique nature of the chitin by having innate water-solubility allows it to be used in a wide range of applications such as agriculture, medical, and environmental (Dave et al., 2021; Pokhrel et al., 2015; Yang, 2011).

7.1. Consumption of insects in Islam

Insects in Arabic "*hasharat*" in the book of *fiqh* are referred to insects,rodents, reptiles. Arabs before Islam were well accustomed to locust consumption (Tajudeen, 2020). When Islam came, locust was further consumed and considered Halal in which Prophet Muhammad (PBUH) said "There are two dead (animals) that are permitted to us (to consume without slaughter); the fish and the locusts" (Ibn Majah, Chapters on Hunting, Hadith No.3218).

It is clear about the consumption of locust in Islam. However, scholars and Islamic jurists differ in opinion about other types of insects.For instance, Hanafi school consider all type of insects as non-Halal (Yasin, 2007). According to the Maliki school of thought, it is considered permissible to consume all types of *hasharat*, including insects, except those that may pose a health risk or are deemed repulsive by people (Rahim, 2018; Tajudeen, 2020). Regarding the Shafi"i and Hanbali schools, they have a specific approach, unlike Hanafi and Maliki schools that have a more general approach. However, both schools have differences in some categories of *hasharat*.Both schools view all insects (except locusts) as dirty, and thus, not Halal (Tajudeen, 2020).

The acceptance of food colorants such as carminic acid (E120), and/or glazing agent such as shellac (E904), in Muslim food industries is questionable due to the different opinions of the Islamic schools of thoughts.

7.2. Halal standards and insects' consumption

OIC/SMIIC 1:2019 standard (Clause no. 5.1.1.1) mentioned that, grasshopper is among the Halal species, and in clause no. 5.1.1.2. mentioned that the repulsive animals such as insects and those that are forbidden to be killed, like honeybee are non-Halal. Malaysian standard (MS 1500:2019, Clause no. 4.5.1.1.1) mentioned that pests, cockroaches, centipedes, scorpions, wasps and other similar type of animals are non-Halal. Those animals that are forbidden to be killed in Islam, like honeybee are non-Halal.Singapore Standard (MUIS-HC-S001,Clause no. A.5.2) considers locust and grasshopper and non-poisonous land carbs as Halal.UAE and GSO standards Standard (GSO/UAE.S 2055-1:2015, Annex 1) mentioned that all types of insects, worms and animals forbidden to be killed by Islamic rules such as ants, bees, except for locusts and unavoidable bee parts falling in honey are non-Halal. MUI (Indonesia HAS 23201) Halal Standard on Materials, includes cochineal coloring (E120) among the Halal materials as well as the crabs and worms, if it is not poisonous.

8. Conclusion

The increasing demand of the Halal products drives the food manufacturer to comply the Halal standards due to its potential commercial advantages. However, there are several Halal standards across the globe which cause no single universal Halal standards accepted worldwide. There are some specific differences of the requirements in each Halal standard which generates confusion to food manufacturers. This study attempts to address the differences and the similarities of five Halal standards: MS 1500, GSO 2055, HAS 23000, MUIS HC S001 and OIC/SMIIC 1. Surprisingly, the differences between the Halal standards are not limited to non-principle requirements; rather, they extend to fundamental criteria, where one standard may accept something that another standard strictly prohibit.

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Halal standardı širom svıjeta: Komparatıvna studija

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Pregledni rad

A R T I C L E I N F O

Ključne riječi:

halal hrana, dijetetske smjernice, islamska regulativa, halal industrija, usklađeni standard

A B S T R A C T

Halal standardi za hranu odnose se na skup smjernica i propisa za muslimane koji reguliraju pripremu, rukovanje i konzumaciju hrane. Ove standarde su objavile različite zemlje i organizacije širom svijeta, što je dovelo do raznolikog raspona halal standarda. Različite objave halal standarda u različitim zemljama predstavljaju izazov za industriju da se uskladi s jedinstvenim standardom, što je rezultiralo složenim i nedosljednim krajolikom. Ova studija ima za cilj usporediti i analizirati glavne halal standarde koji se koriste u cijelom svijetu, uključujući MS 1500 iz Malezije, GSO 2055-1 iz Vijeća za suradnju u Zaljevu, HAS 23000 iz Indonezije, MUIS HC S001 iz Singapura i OIC/SMIIC 1 iz Organizacije zemalja Islamske suradnje (OIC). Ova studija će usporediti različite aspekte glavnih halal standarda uključujući, ali ne ograničavajući se na metode koje se koriste za omamljivanje životinja, mehaničko klanje, klanje od strane ljudi iz knjige, upotrebu i koncentraciju alkohola, insekte i njihove nusproizvode, te preradu octa. Rezultati ove studije omogućit će bolje razumijevanje razlika u halal standardima i njihov utjecaj na globalnu halal industriju. Očekuje se da će ova studija pomoći sudionicima da razumiju te standarde i doprinijeti razvoju usklađenih halal standarda u budućnosti.