Trends in Food Science & Technology 58 (2016) 55–68

Contents lists available at ScienceDirect

Trends in Food Science & Technology

journal homepage: http://www.journals.elsevier.com/trends-in-food-science-and-technology

From market to food plate: Current trusted technology and innovations in halal food analysis

Hamadah Nur Lubis [a, 1], Noor Faizah Mohd-Naim [b, c, 1], Nur Nazurah Alizul [a], Minhaz Uddin Ahmed [a, *]

[a] Biosensors and Biotechnology Laboratory, Integrated Science Building, Faculty of Science, Universiti Brunei Darussalam, Tungku Link Road, BE 1410, Brunei Darussalam
[b] Faculty of Medicine, Sir Alexander Fleming Building, Imperial College London, SW7 2AZ, United Kingdom
[c] PAPRSB Institute of Health Science, Universiti Brunei Darussalam, Jalan Tungku Link, Gadong, BE 1410, Brunei Darussalam

ARTICLE INFO

Article history:
Received 31 January 2016
Received in revised form
7 August 2016
Accepted 27 October 2016
Available online 18 November 2016

Keywords:
Halal food
Porcine
Pork
Alcohol
DNA and protein

ABSTRACT

Background: The global halal industry is currently the fastest growing consumer segments in the world, estimated to be worth over one trillion dollars. It has become a powerful market force with Muslims and non-Muslims alike with future demand for halal food likely to remain strong. With halal products becoming mainstream consumer goods, incorrect certification of the halal brand on food products has become a worryingly regular occurrence. In order to rapidly verify the halal authentication of food products, sensitive, easy-to-use and reliable scientific method is especially required for halal food screening.

Scope and approach: In this review, we will explain what is considered as halal food before describing existing methodologies and their limitations in detecting and identifying non-halal components in food products. We will also present important technological innovations with significant potential as routine detection tools for halal analysis.

Key findings and conclusions: The most commonly used molecular biomarkers during food analyses are proteins and DNA. Although DNA is generally considered to be most appropriate for animal species detection, it still presents numerous drawbacks. Nonetheless, with rapid development of modern technology in biological analysis, a number of approaches incorporating latest biotechnological innovations with regards to halal authentication have emerged such as point-of-care diagnostics and integration of assays with smartphones. It is clear that the evolution of the halal industry presents itself as a lucrative market to be tapped into and needs to be supported by reliable and efficient screening methods to ensure that food production is aligned with the halal principles.

1. Introduction

Halal food and beverage market is currently gaining momentum and is predicted to be worth up to US$1.6tn and contribute up to 17.4% of the world food market by 2018 (Thomson Reuters, 2015). This is only set to grow as the world's Muslim population, currently estimated at 1.6bn, is expected to reach 2.2bn by 2030, making up the core market of halal products. The halal principle is founded on Islamic ideals that emphasise purity and cleanliness to promote one's health and wholesomeness. Intriguingly, this also appeals to non-Muslims consumers, who care about the governance and sustainability of their food, particularly organic food partisans. Although the concept of halal may be centuries old, the benefits are relevant to our current focus on conscientious eating and ethical sourcing of safe food.

In recent years, however, halal food consumers are increasingly concerned about the halal authenticity of their food. In particular, pork meat substitution and the use of undeclared prohibited ingredients in food products are only some of the issues that plague Muslim buyers. Monetary benefits have encouraged the meat processing industry to commit adulteration and fraud either by substituting food ingredients for implicit alternatives that are

* Corresponding author.
E-mail addresses: minhaz.ahmed@ubd.edu.bn, minhazua@gmail.com (M.U. Ahmed).
[1] Note: Hamadah Nur Lubis and Noor Faizah Mohd-Naim have contributed equally in this manuscript.

http://dx.doi.org/10.1016/j.tifs.2016.10.024
0924-2244/

cheaper or adding elusive substances to add product weight so that the product appear to be of higher value. Methods for halal authentication of food products are of paramount important to ensure consumers protection.

Various reviews have previously been published in relation to the analysis and detection methods of pork derivatives in food. Rohman and Che Man (2008, 2012) described the analytical techniques of studying porcine proteins while other reviews additionally described other methods used to analyse porcine DNA in halal food screening (Mursyidi, 2013; Nakyinsige, Man, & Sazili, 2012). In this review, we will briefly present current biological detection techniques in the analysis of both porcine protein and DNA, including their limitations. Furthermore, we will summarise commercial kits currently available for the detection of porcine protein and DNA developed for and targeted to halal consumers and testing laboratories. More importantly, this review will highlight some biological innovations reported in recent years, which have great potential for their future development as halal screening tools in order to overcome the drawbacks set by current biological detection methods.

2. What is halal?

Muslims consume foods that are deemed halal, which means allowed, permitted and wholesome in Arabic (Khattak et al., 2011). Food or drink that is permitted for consumption must be confirmed by the Islamic law as revealed in the Quran or the tradition of Prophet Muhammad (hadith). Descriptions of the type of foods that are permissible for consumption are further specified in the following sections.

3. Various food types and their halal classification

All food can be consumed by Muslims except those that are made of or contain the following: carrion or dead animals, blood (flowing or congealed), swine and all its derivatives, animals slaughtered in the name of any other than Allah (how Muslims refer to their God) or not according to Islamic law, animals that were killed accidentally or on purpose through means such as strangling or beating, intoxicants (alcohol and drugs), carnivorous animals, predator birds, and certain land animals (Khattak et al., 2011; Riaz & Chaudry, 2003). The slaughtering procedure needs to be performed by a sane Muslim who invokes Allah's name while slaughtering and cut the animal's jugular vein in the neck with a sharp knife. This is to allow the rapid draining of blood in order to ensure the quickest death for the animal (Khattak et al., 2011).

4. Animal meat and blood

Meat that is permitted in Islam is those from domesticated animals such as goat, sheep, cattle, buffalo and camel, which are all ruminants possessing split hoof with padding in between. Meanwhile, meats from pigs, boars and swines, or any of their derivatives are strictly forbidden. Birds such as chicken, duck, turkeys, pigeons and quails, among others, are allowed. Prey birds with sharp claws such as eagles, falcons and vultures are not permissible. Fresh, raw meat from permitted animal is halal as long as the animal was slaughtered accordingly and that the place of slaughter is not contaminated with any pork meat or its derivatives (Hassan & Lewis, 2014; Khattak et al., 2011). Meat can undergo various treatments that may result in changes to its original taste, structure and texture. During the processing of meat, adulteration can occur whereby the meat is mixed or substituted with alternative meats that are cheaper and more easily available, such as pork (Nakyinsige et al., 2012). This becomes an added concern for Muslim consumers when purchasing meat.

Consumption of blood or blood plasma is forbidden in Islam (Hassan & Lewis, 2014; Khattak et al., 2011). Hence, any food products made of or containing blood or blood plasma, such as blood sausages, are prohibited and are not considered halal.

5. Fish and seafood

Generally, fishes and seafood, such as molluscs and crustaceans, are halal for Muslims consumption (Hassan & Lewis, 2014; Khattak et al., 2011). Precautions only arise with processed seafood products such as surimi, fish cakes, fish fillets and fish balls, such that they neither contain nor become contaminated with any non-halal ingredients.

6. Food ingredients

Specific food ingredients play a major role in determining whether a food product is halal or otherwise. Vegetable and its derivatives are halal as long as they are not adulterated with non-halal ingredients or intoxicating substances. Gelatin, enzymes and lard are examples of common food ingredients that may become a point of concern for Muslims.

Gelatin can be extracted from several sources including pigskins, bovine hides and splits, and bone materials from animals including fish (Cai, Gu, Scanlan, Ramatlapeng, & Lively, 2012; Elgadir, Mirghani, & Adam, 2013). Porcine gelatin has been the preferred type in non-Muslims countries due to its cheaper price and has been regularly used in place of beef gelatin to prevent mad cow disease contraction (Elgadir et al., 2013). Enzymes are complex organic molecules that can be derived from plants, animals and microorganisms. Hence, it is important to note, should enzymes be present in a product, the source of enzymes, and to ensure it is not extracted from prohibited animals. Lard is a type of fat that is derived from pork, and because pork is strictly forbidden in Muslim diet all food products that contain lard must also be avoided.

7. Milk products

In the dairy industry, cheese-making traditionally requires a substance called rennet that is used to coagulate milk curds into cheese. Rennet is usually extracted from the stomach lining of newly born ruminants including pig. However, thanks to the advancement of science, cheese manufacturers nowadays have the option of using microbial or fungal rennet as a substitute in cheese making. The source of rennet used in cheese production must therefore be stated on the package labelling to aid Muslim consumers.

Yogurt, cultured milk, cream and sour cream are made from processed milk. Milk is generally halal if it is produced from permissible animals. However, other ingredients such as gelatin, emulsifiers, colourings, stabilisers and enzymes may be added, usually to produce the desired texture, colour and to extend its shelf-life. Provided that all other ingredients are obtained from halal sources, the milk product is considered halal.

8. Beverages and alcohol-containing foods

In Islamic Law, according to both the Quran and the Prophet's hadith, all intoxicants are forbidden, which includes alcoholic drinks (Regenstein, Chaudry, & Regenstein, 2003). The general hadith that discusses this stated that “anything which when consumed in a large quantity causes one to become drunk, then the consumption of a small quantity of it is also haram”. Alcohol itself is not specifically mentioned in the Quran and hadith. What is