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Gelatin; Switch back to Halal: A Mini-Review

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Abstract:
Gelatin is a traditional functional protein with water-soluble properties and has the potential of forming transparent gels under certain conditions. The main source of gelatin is pigskin and is widely used in processed food and medicinal products. Though the use of food products adulterated with porcine-derived gelatin create concerns in the mind of Muslims community, as in Islam, it is not acceptable or literally, we call it Haram. However, in recent times initiatives have been taken in producing gelatin from Halal sources, such as fish, chicken and bovine slaughtered according to Islamic teachings. Therefore, we highlighted different porcine alternative derived gelatin sources and also methods to detect edible product adulterated with pork or other haram stuff. This review could be useful in providing information to a large number of audience and food processing companies to minimize or if possible eradicate the use of porcine-derived gelatin in commercial food and medicinal products.

Keywords: Gelatin, Muslims, Halal, fish, chicken.

INTRODUCTION

Gelatin is a fibrous protein with high molecular weight, derived from collagen which comprises about 25 to 35% of total body protein, through thermal hydrolysis (Tabarestani *et al.*, 2010; Vijayaraghavan *et al.*, 2009). It is the main protein connective tissue and widely found in mammals, birds, and fishes (Eysturskarð *et al.*, 2009; Rawdkuen *et al.*, 2013). In general, gelatin plays a role in food processing and formulation (i.e. gelling process and some respond to the surface behavior of gelatin) (Karim and Bhat, 2008). The other functional properties of gelatin are of foaming, emulsifying, setting index and water holding capacity (Rawdkuen *et al.*, 2013). Gelatin is commercially used in food, pharmaceutics, cosmetics, and photographic application (Figueroa-Lopez *et al.*, 2018; Nur Hanani *et al.*, 2013; Rose *et al.*, 2014; Salamon *et al.*, 2014; Schrieber and Gareis, 2007).

The Muslim population share 23.4% of the total world population (1.6 billion), which has been reported by Jamaluddin et al (Jamaludin *et al.*, 2011). The ever-growing Muslim population and demands for halal food are on the rise (Easterbrook and Maddern, 2008). Regarding the increase in demand of halal food, an issue is raised by many scholar and scientist that, gelatin which is mainly derived from the pig skin (Boran and Regenstein, 2010) is used in almost every processed food products. However, Muslim do not approve gelatin derived from prohibited sources like porcine gelatin except the extreme situation where there is no other alternative (Eriksson *et al.*, 2013). In contrast to that, pork derived gelatin can be replaced by using gelatin derived from halal sources. Such as fish (Mahmoodani *et al.*, 2014), cow (Andiç *et al.*, 2013), chicken and turkey(Du *et al.*, 2013) derived gelatin.

In the recent past, a handsome amount of review article has been published (Babel, 1996; Djagny *et al.*, 2001; Karim and Bhat, 2008; Mariod and Fadul, 2013). However, based on our exploration capability, no comprehensive study is available to clearly distinguish between porcine and it's alternative (Halal) derived gelatin. The need of this study is to shed light over the issue of Halal and Haram gelatin-based products consumptions. Further, showcased its importance in improving antioxidant activities and also outline some methodology to detect porcine adulteration and market data of major Islamic countries. This review might be helpful in the future regarding knowledge and significance about porcine and its Halal alternative derived gelatin.

Sources of Gelatin

The primary source of gelatin is pigskin, but some other sources are also contributing in fulfilling the requirement of gelatin production (Boran and Regenstein, 2010; Sai-Ut *et al.*, 2012). As it contributes 46% to the total production of gelatin along with bovine hide (29.4) and pork and cattle bones (23.1%) (Gómez-Guillén *et al.*, 2011). However, a considerable amount of attention has been given to the alternatives of porcine gelatin (Morrison *et al.*, 1999). Further talking about porcine-derived gelatin alternatives, the fish gelatin market share is still very small comparing to bovine and porcine gelatin (Choi and Regenstein, 2000). But there are a sizeable amount of available scientific studies reported that aquatic source derived gelatin exhibit better film-forming properties than that of mammalians (Avena-Bustillos *et al.*, 2011). In addition to that, fish gelatin with a lower melting point was reported for having good release properties of food sensory attributes (Aewsiri *et al.*, 2009). Therefore, it became an important issue to provide gelatin derived from *Halal* Sources. In contrast to which, gelatin derived from poultry, animals (considered as *Halal and slaughter according to according Islamic rules)* and especially marine sources (Bhat and Karim, 2009) can be accepted as *Halal* and might be a potential alternative for porcine gelatin (Table 1).

Table 1. Different raw sources of commercially produced gelatin.

Source	Gel Strength (g)	Reference
Aquatic		
Farmed giant catfish (*Pangasianodon gigas*) skins	153	(Jongjareonrak *et al.*, 2010)
Mrigal (*Cirrhinus mrigala*) skins	343	(Madhamuthanalli and Bangalore, 2014)
Silver carp (*Hypophthalmichthys molitrix*) skins	600	(Boran and Regenstein, 2010)
Catla (*Catla catla*) swim bladders	265	(Chandra and Shamasundar, 2015)
Nile perch (*Lates niloticus*) skins	240	(Muyonga *et al.*, 2004)
Rainbow trout (*Onchorhynchus mykiss*) skins	459	(Tabarestani *et al.*, 2010)
Alaska pollock skins	98	(Zhou *et al.*, 2006)
Dover sole *(solea vulgaris)*	350	(Gómez-Guillén *et al.*, 2002)
seabass *(Lates calcarifer)*	321	(Sinthusamran *et al.*, 2015)
Grey triggerfish	190	(Souissi *et al.*, 2017)
Catfish (*Pangasius sutchi*) bone	254	(Mahmoodani *et al.*, 2014)
Pink perch (*Nemipterus japonicas*) skins	140	(Koli *et al.*, 2012)
Pink perch (*Nemipterus japonicas*) bones	130	
Mammals		
Bovine skin	225	(Samal *et al.*, 2015)
Pork skin	372	(Hafidz *et al.*, 2011)
Cattle short tendons	350-410	(Mokrejs *et al.*, 2009; Ran and Wang, 2014)
Goatskin	226	(Mad-Ali *et al.*, 2016)
Yak skin	NA	(Xu *et al.*, 2017)
Poultry		
Chicken shank and toes	148	(Abdullah *et al.*, 2016)
Skins and tendons of chicken feet	294	(Almeida and Lannes, 2013)
Chicken and turkey heads	332-368	(Du *et al.*, 2013)
Peking Duck	218	(Abedinia *et al.*, 2017)

Commercial uses of Gelatin

The unique gelling, stabilizing, healing, ointment, capsule and coating properties of gelatin made it as the most widely used biodegradable compound in commercial food produces, pharmaceutical and photographic industries (Djagny *et al.*, 2001; Howe, 2000; Ulubayram *et al.*, 2001; van Eerd *et al.*, 2006; Wang *et al.*, 2012). The clear and transparent structure of gelatin accounts for its significance, especially in food and pharmaceutical industries (Djagny *et al.*, 2001). Further, it has been reported that, annually, tons of gelatin has been used in candies, desert, meat, ice cream and bakery products (Djagny *et al.*, 2001; Johnston-Banks, 1990). Moreover, the gelatin also inhibits the recrystallization of lactose sugar during cold storage (Jamilah and Harvinder, 2002). While in pharmaceutical industries, the making of hard and soft capsule shell, tablets, granulation and syrups, all required gelatin. Because the gelatin serves as a natural coating material and also highly digestible. According to a report, approximately 6% of the total gelatin production is used in pharmaceutical industries (Hidaka and Liu, 2003). For sports industry, gelation does play its role in energy drinks production for athlete also utilize gelatin as a necessary component of energy drink (Phillips and Williams, 2011). In photography, it was first used in 1871 after coating the sensitizing agent on a glass plate in gelatin. Furthermore, the use of gelatin in cosmetic industries is of high importance, as it is commonly used in shampoo, lipstick, conditioner, cream and fingernail formulas (link available for reference # 54 in the reference section) (http://www.vyse.com/applications_by_industry.html). Furthermore, gelatin derived from aquatic sources may be more applicable in the halal/kosher market than that of mammalian and porcine gelatin.

Antioxidant properties of gelatin derived from Halal and porcine sources

The increase in the production of biodegradable polymer like gelatin getting worldwide attention, one of the reasons why producer finds it as an attractive option is due to its antioxidant properties (Arvanitoyannis, 2002; Kavoosi *et al.*, 2013). There are many sources of gelatin, however, there is a notable growing interest in producing gelatin from fish waste because of the outbreak of mad cow disease and the unacceptability of bovine and porcine-derived gelatin by Muslims, Jews and Hindus community (Haug *et al.*, 2004). Adding to this, fish gelatin possess biologically active peptide and such peptides have the potential to act as an antioxidant against the like of linoleic acid (Kim *et al.*, 2001b; Mendis *et al.*, 2005). Further, the fish gelatin hydrolyzes with papain to produce antioxidant peptides, which exhibit high radical scavenging properties (You *et al.*, 2010). In contrast to that, hydrolysate derived from fish gelatin can be used as a functional food material that induces immunity against ultraviolet A in the skin and also protects food and others biological system from oxidation (Kato *et al.*, 2011; Sai-Ut *et al.*, 2012). Moreover, the gelatin derived from the Pacific cod skin was hydrolyzed with pepsin and produced two bioactive peptides namely GASSGMPG (662 Da) and LAYA (436 Da) (Ngo *et al.*, 2016). This showed the strong inhibitory effect of Angiotensin- I- converting enzyme (ACE), an important enzyme in the control of hypertension and type-2 diabetes (Ngo *et al.*, 2016). Further, they suggested using it in functional food preparation to lower the blood pressure and cardiovascular diseases (CVD) (Ngo *et al.*, 2016). In another study, gelatin from cuttlefish was reported for stopping the β-carotene bleaching by donating an atom to peroxyl radicals of linoleic acid. Which further demonstrated its importance in protecting food from drying and exposure to light (Jridi *et al.*, 2013). Meanwhile, gelatin derived from the poultry waste also exhibit metal chelating and radical scavenging properties and can be considered as a *Halal* alternative of porcine gelatin (Omar and Sarbon, 2016). Some other valuable peptides were also reported for its beneficial activity by many researchers confirmed the broad and wide range of available and functional peptides from porcine alternative

sources (Kim *et al.*, 2001a; Kim *et al.*, 2001b; Mendis *et al.*, 2005; Nakade *et al.*, 2008; Saiga *et al.*, 2008). Thereby, according to Jridi et al (Jridi *et al.*, 2013), all gelatins in all probability contained peptides which are electron or hydrogen donors that converts the free radical to the more stable product by reacting with them and dismiss the radical chain reaction (Jridi *et al.*, 2013). However, we will suggest after studying the recent research that fish gelatin (advantage of having odorless properties) has an edge over poultry gelatin due to the complication in managing poultry wastes (Jayathilakan *et al.*, 2012). Therefore fish gelatin can be utilized as a substitute antioxidant driver for porcine and bovine-derived gelatin.

Techniques regarding detection of porcine adulteration

In the recent times, about 50,000 tons of beef meat has been found adulterated with horse meat in Europe (Ahmad, 2009). This cannot be an accident but a fraudulent act to mix the meat of different species such as horse or pork and blend it into the cattle beef, which creates concerns in the mind of ethnical groups (Muslims and Jews) (von Bargen *et al.*, 2013). As the 1.5 billion Muslims shares around 20% of the world population and for them, the use of porcine-derived food products is strictly prohibited according to the teaching of Islam (Shabani *et al.*, 2015; von Bargen *et al.*, 2013). Such is the case with the production of gelatin as well. According to a report, about 80% of gelatin produced from the pigskin in Europe (Boran and Regenstein, 2010). In addition to that, most of the food manufacturers use porcine-derived gelatin rather than its diverse alternatives (Batu *et al.*, 2015; Shabani *et al.*, 2015). Due to the vast use of porcine gelatin, it is must for the Muslims to test the processed food for the detection of porcine-derived gelatin adulteration (Riaz and Chaudry, 2003). Because for the Muslim, the tolerance level becomes 0% when it comes to porcine and porcine-derived gelatin contamination in processed foods (von Bargen *et al.*, 2013). Therefore we tabulated some of the advanced techniques regarding the detection of porcine gelatin in food products, from the previously published research articles (Table 2).

Table 2. Various techniques for screening porcine adulterated produces at molecular level.

Techniques	Subjected product	References
RT-PCR (primer D-Loop 108)	Capsule shell	(Sudjadi *et al.*, 2016)
RT-PCR (using porcine specific primers)	Processed food products	(Demirhan *et al.*, 2012)
Species-specific duplex polymerase chain reaction (PCR)	Gelatin capsules	(Nikzad *et al.*, 2017)
Multiple reaction monitoring (MRM)	Halal beef	(von Bargen *et al.*, 2013)
Surface Plasmon resonance (SPR)	Gelatin	(Wardani *et al.*, 2015)
Species-specific PCR using mitochondrial DNA	Gelatin	(Shabani *et al.*, 2015)
Species-specific coupled with whole-genome amplification	Gelatin capsules	(Lee *et al.*, 2016)
Conventional and real-time PCR	Edible gelatin	(Tasara *et al.*, 2005)

Opportunity for industrial and market boost

The contribution from the waste of livestock, fisheries and poultry industry is important for a country GDP growth (Jayathilakan *et al.*, 2012). The main reason is that animal byproducts have the capability of decreasing the level of protein malnutrition and food insecurity (Alao *et al.*, 2017). According to the available online data, Muslim countries produce heaves of animal waste and do have the potential of producing a large amount of Halal gelatin (Table 3). However, the exported values (table 3) showing a huge gap between the production of gelatin and the other variables (Meat and fisheries). This clearly showcasing the poor management of animal byproducts in all the major Islamic countries. The reason might be lack of production facility and less knowledge about managing animal waste products. Therefore more attention is needed particularly in the area of managing waste from farm animals, aquatic sources and poultry industry. As it is important to boost the local market economy, decrease concerns regarding the use of Halal and Haram gelatin and also increase the country economy by reducing the percentage of imported gelatin.

Table 3. Meat, Fish and gelatin production capacity of major Islamic countries.

Countries	Exported value of (US Dollar Thousand)		
	Meat (offal)	Fisheries	Gelatin
Pakistan	239,741	336,380	5,639
Malaysia	49,135	516,249	227
Iran (Islamic Republic)	30,861	168,352	0
Turkey	370,847	744,561	21,531
Indonesia	20,715	2,900,604	113
Israel	1,349	13,685	128
Tunisia	2,129	126,159	374
United Arab Emirates	53,463	123,412	233
Qatar	2,514	1,253	0
Bangladesh	987	No data	1,194
Lebanon	968	672	0
Oman	91,864	162,864	1
Jordan	45,258	745	192

Source: https://www.trademap.org/tradestat/Index.aspx

CONCLUSION

The need for this review is to highlight the issue regarding Halal and Haram gelatin. As the major gelatin source in the international market is pigskin but it is always controversial for ethnical groups, such as Muslims and Jews. Therefore we summarized different porcine alternative gelatin sources, which provide better gelling, antioxidant and functional properties than that of porcine-derived gelatin. In addition to that, we tabulated some market data of major Islamic countries, which clearly suggests that all those stated countries have the ability to produce handsome amount of Halal gelatin and can make themselves gelatin sufficient. However, apart from Turkey, all other countries are producing gelatin less than their average requirement. The reasons must be varied such as lack of waste management practices and industrial technology. Therefore, more work is required in the sector of waste management and adopting state of the art industrial technology to produce Halal gelatin inside the country.

CONFLICT OF INTEREST

The author declares that no conflict of interest exists.

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