

Development of Gelatin from Halal and Alternative Sources: A Review

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Abstract

Gelatin is a common ingredient used in various industrial sectors including food and beverage, cosmetic, pharmaceutical as well as biomedical. Due to inexpensive processing cost and shorter processing time, porcine becomes the main source of gelatin. Thus, the application of this ingredient creates several problems especially issues related to its halal status among Muslim community. The present study aims at reviewing the development of gelatin from halal sources and their potential as alternatives to substitute the sources of non-halal gelatins. The applications of gelatin in food industry and the current issues on halal gelatin have been discussed in detail. The halal source of gelatin required intense study due to prominent demand of it not only in food industry but also in pharmaceutical industry. The development of halal gelatin provides Muslim alternatives and choices to consume gelatin as food and pharmaceutical products and yet complying with Islamic obligations.

Keywords: Gelatin, Food Industry, Islamic, Halal, Alternative Sources.

Introduction

In the last few decades, food manufacturing has been prepared based on the expansion of modern science and technology. There are quite a lot of ingredient sources which have been used in the production of food products including gelatin. Gelatin is a protein derived from collagen, acquired by heating collagen exceeding its denaturation temperature that will lead to a structural collapse. Gelatin basically is made up of 19 amino acids vastly content of hydroxyproline, proline and glycine, thus it has lower molecular weights than collagen [1].

The functions of gelatin in food industry include improving the texture of the food, increasing preservation of the food in low temperature, refining stability, and extending shelf life. In candy manufacturing, gelatin acts as the gelling agent in gel candies, adhesives agent in chewing gum and emulsifier in fruity cream candy. While in the production of processed meat like head cheese, chicken rolls and jellied meat, gelatin is used to absorb meat juices and give strength to the products. Gelatin turns out to be irreplaceable supporting materials in food industry for its ultimate physical properties, great purity content and various uses [2].

In term of regulation halal gelatin, it does not only focusing on the resources being used but also the process that is being implemented to produce products. The Halal concept must be protected throughout the supply chain 'from farm to fork'. The whole processes from choosing animal sources to produce gelatin, slaughtering, extracting, manufacturing, packaging and all the way to the consumer must be complied to Shariah law.

There are abundance sources of non-Halal gelatin, and the sources of the ingredient are not stated at the food packaging, making confusion to the Muslim consumer. Despite of this situation, there are other options and many alternatives to substitute this auxiliary food element. Therefore, the major purpose of this paper is to report on current development of Halal sources gelatin and to list out the alternatives to replace the non-Halal gelatin.

Functional Properties of Gelatin

The properties of gelatin based on the source and type of collagen used during production process. The functional properties of gelatin can be divided into two groups which are gelling and surface properties. The gelling properties include gel strength, viscosity, and gelling time, setting, and melting temperatures, thickening, and texturizing and water retention properties. The gelatin's surface properties provide information regarding film formation and adhesion/cohesion, emulsion formation and stabilization, protective colloid function, foam formation and stabilization [3].

Gelatin has many special properties which are not easily imitated by hydrocolloids such as "melt-in-the-mouth" properties that melting slightly below body temperature (<35°C). It gives the polymer the special "melt-in-mouth" perception leading to intensive flavor and aroma release [1]. Based on the previous studies, scientists have not been able to find a gelling protein or polysaccharide, which universally able to replace gelatin as a gelling agent (Karim and Rajeev, 2008). Unlike most protein and other polysaccharide gels, gelatin gels are thermoreversible. They can reversibly turn into liquid from gelling from when heated at certain temperature. Some plant hydrocolloids such as carrageenan and agar can perform thermally reversible gels too, however the melting points are slightly higher than that gelatin gels [2].

Another important feature of gelatin is the surface activity. Gelatin does not have high surface activity when compared to gum Arabic. The emulsifying or stabilizing properties are lower than that of gum Arabic, yet this characteristic of gelatin is crucial especially when combine with the gel forming abilities of gelatin [4]. Gelatin can be considered as one of the most versatile hydrocolloids in food industry. Due to its vast multi-functional properties covering from gelling, thickening, water-binding, emulsifying, foaming, film-foaming agents, gelatin known as

irreplaceable hydrocolloid since no other single hydrocolloid gives the same combination of functionalities [4].

Gelatin is available in different gel strengths and particle sizes based on specific applications. In contrast, plant hydrocolloids do not have the gel strengths. Modification of jelly strength must be blending with other ingredients such as sugars and salts. Other than that, the gel of gelatin is convenient to be used within the normal pH range suitable for most foods and it does not require the addition of salts or sugars. Gelling hydrocolloids frequently require the addition of salts, sugars or food acids to make a gel [5].

Sources of gelatin

The sources of gelatin can be agricultural like hydrocolloid or non-agricultural source such as sources from cattle bones, hides, pig skins, and fish [6]. These sources can be Halal or non-Halal gelatin.

Porcine and bovines

Gelatin obtained from porcine are known as Type A Gelatin and widely used in food industry. Graduate Medical Education, GME (2008) reports the annual world production of gelatin is nearly 326,000 tons per year [7] followed by bovine hides (29.4%), bones (23.1%) and other sources (1.5%) [7]. This type of gelatin is processed in a shorter period by mixing with acid and eventually producing good quality and great amount of product (Type A gelatin). Another types of gelatin is Type B Gelatin obtained from bovines' bones and skins like cows and buffaloes which requires lengthy treatment with alkali or lime water [8]. The purpose of alkali or acid pre-treatment is to broken the structure of collagen, solubilize the non-collagen proteins and hydrolyze the peptide bonds, yet maintaining the consistency of the collagen fibers [9]. The raw materials derived from these mammals are limited and the price is higher compared to porcine.

Gelatin alternatives

Gelatin replacement has been discussed in recent years due to the emerging and profitable vegetarian, Halal, and kosher markets. It has recently gained increased interest, and scientists have been studied regarding these issues especially within Europe due to emergence of bovine spongiform encephalopathy (BSE) known as 'mad cow diseases' in the 1980s and mouth disease (FMD) [5]. Since that, there has been much concern about using gelatin derived from infected animal parts. Therefore. A few alternatives to replace the source of gelatin from mammals to other potential sources have been proposed.

Hydrocolloid

Hydrocolloid is one of the alternatives to replace the mammalian sources. Hydrocolloids can be defined as hydrophilic polymer mostly derived from natural polysaccharide sources that dispersed in water like seaweed. The properties of hydrocolloid are solubility [10], viscosity including **thickening** and gelling and water binding but also important in emulsion stabilization, prevention of ice recrystallization and organoleptic properties. Another application of hydrocolloid include adhesion, suspension, flocculation, foam stabilization and film formation.

Unlike gelatin, hydrocolloid do not have the defined melt set characteristics such as gellan, alginate or carrageenan-based gels. The polysaccharide-based gelatin alternatives generally have less flexible molecular backbones, leading to higher viscosities than gelatin [5].

Poultry

Poultry sources like chicken and duck are other alternatives used to replace mammalian sources for Halal gelatin production. Poultry can be used to replace the gelatin if the animal obtained from trusted sources and slaughtered in Islamic way [3,7]. New gelatin sources such as poultry skin, feet, bone, and eggshell have been used to replace mammalian.

Gelatin production from waste product of poultry especially from the feet of poultry contain high concentration of collagen compared to poultry skin. Collagen extracted from chicken broiler feet had higher hydroxyproline (Hyp) and proline (Pro) content and exhibited higher thermal stability. The vast chicken and duck production in Malaysia has produce poultry waste by-products (feet), and provide readily available raw material source to produce poultry feet gelatin [7]. In South Korea, a traditional Korean gel-type food have been done previously studies on the feasibility of using chicken feet to replace cowhides for *jokpyun* [7].

Chicken gelatin has a chemical composition like bovine gelatin and better physicochemical properties compared with those reported for fish gelatins. The gel strength of chicken gelatin was significantly higher than that of bovine gelatin and both formed stable structures on cooling. Chicken gelatin showed higher gelling temperatures compared to bovine gelatin [9].

Apart from feet, skin derived from poultry has a potential as an alternative sources of Halal gelatin. Norizah [11] reported that gel strength from chicken skin-gelatin has significantly higher bloom value (355) compared with those of bovine gelatin (229) Chicken skin contains about 75% type I and 15% type III collagens [7]. Chicken skin is potentially made into animal meal and the other smaller proportion is used in making meat emulsions or used as a source of fat such as for soup preparation.

Fish

Gelatin from marine sources is a better alternatives to replace bovine gelatin as they have lower melting point in which it can speed up the dissolution process in the mouth with no residual 'chewy' mouthfeel [3]. Fish gelatin is acceptable for Islam and can be used with minimal restrictions in Judaism and Hinduism. Unlike mammalian, marine gelatin sources are not related with the risk of outbreaks of Bovine Spongiform Encephalopathy. Gelatin can be extracted from skins and bones of various cold-water (e.g., cod, hake, Alaska pollock, and salmon) and warm-water (e.g., tuna, catfish, tilapia, Nile perch, shark, and megrim) fish. Major byproduct of the fish-processing industry such as fish skin provides a valuable source of gelatin [5]. The cold-water fish gelatins basically exhibit good film formation and have high quality of emulsifying properties. Recently, the main application areas are to produce pharmaceutical product, an implant from oil-based vitamins in by using spray-drying or using micro-encapsulation techniques. In contrast, the warm-water fish gelatin produced good gelling properties and is used in the food and pharmaceutical industries [3].

Fish skin contains a large amount of collagen. Fish collagens have lower imino acid contents compared to mammalian make it have lower denaturation temperature (Karim and Rajeev, 2008). It was reported that the main differences between fish and mammalian gelatin is the content of the imino acids proline and hydroxyproline, which stabilizes the conformation configuration gelatin in forming gelatin gel network. The lower percent of proline and hydroxyproline resulting in low gel modulus, gelling, and melting temperature of fish gelatin. Cold-water fish gelatin like pollock and salmon, have low gelling temperature (8°C) and melting temperatures compared to mammalian and warm-water fish gelatins (Karim and Rajeev, 2008).

Insects

Insects are another source of gelatin that is acceptable for Muslim's consumption, but the utilization of this type of source is still limited. In Sudan there are many edible insects and desert locust insect species is the most famous one in that country beside sorghum and melon bugs. Melon bug, *Aspongopus viduatus* and sorghum bug, *Agonoscelis pubescens*, also known as Umbugga and Dura andat in Sudan [12] The collected bugs were extracted and the oil produced from the process was used for cooking and some medicinal purposes [6].

Three different methods of extraction were used to extract gelatin from *A. viduatus* and *A. pubescens* which were mild acid and distilled water extraction method, distilled water extraction method and extraction with hot water method. Based on the three methods used, the extraction of insect gelatin using hot water gave higher yield extraction of gelatin up to 3.0% followed by mild acid extraction 1.5% and distilled water extraction 1.0%, respectively [6].

Camel

Camel is one of new source of Halal gelatin alternative that still being under studies. Camel is an important animal in Saudi Arabia, and it is expected that the production of Halal gelatin derived from camel will assist the development of Halal industry and Halal business in the country. The extraction and characterizations of gelatin derived from camel have been carried out in the previous studies [13]. The physic-chemical, nutritional, rheological and quality properties of the camel gelatin is compared to other types of gelatins, bovine, and porcine gelatins. In another study, gelatin has been extracted from camel hide and the produced gelatin showed the bloom strength of 152g which is comparable to other gelatin that are readily available in the market like bovine and porcine [13].

Current issues on halal gelatin

Nowadays Halal issue become a hot topic in the market and since Malaysia is an Islamic country, of course Halal concept is an important key point in food industry. The abundance of non-Halal gelatins which are easily available in the market due to low cost and mass production by non-Muslim companies has created a major issue in the Halal industry. The main source for the non-Halal gelatin is derived from porcine. Swine resources are becoming sustainable due to their eligibility in almost countries in the world. Other than that, there are also lots of undeclared ingredients in the food packaging. The raw materials of the ingredient are very hard and challenging to be tested because the products are coming from all around the world, leaving a question mark about their Halal status.

Another issue is the confusion in the use of 'pork-free' term. In the market, the concept of Halal is not only restricted to the pork meat or the term 'pork free'. The term of 'pork free' is not enough because it cannot encompass the whole concept of Halal. Sometimes the food does not contain any pork meat but still has the element of pig or we call it as porcine. The producer of gelatin especially the non-Muslim should have a depth understanding about the Halal conception. They must obey the Islamic Law, which comprise a ban on using any pig-base products. A Halal gelatin must be derived from Bovine sources and that sources must be slaughtered according to the Shariah Law, marine and other sources which can be considered Halal.

Commonly, when societies talk about Halal, there is a missing element which is tayyiban. It is a compulsory for halal and tayyiban concept to be applied together. If the element of tayyiban is missing, the food is no longer be considered as Halal. Tayyiban concepts consist of good, healthy, safe, clean, nutritious, and high quality of halal products. Tayyiban can be defined by the wholesomeness of the food in which covers the permissible requirements of Islamic Law. Even if the producer claim that their gelatin is produce from Halal bovine and slaughtered properly according to syari'ah, but their workplace is dirty and not having a Good Hygienic Practice (GHP) and Good Manufacturing Practice (GMP), their halal status can be withdrawn.

Conclusions

Throughout the industry, Halal necessities must be obeyed to at all phases of the production and supply chain, as well as procurement of raw materials and ingredients, logistics and transportation, packaging, and labeling. Muslims only allowing the use of gelatin derived from Halal animals and they must be slaughtered in the name of Allah. Meanwhile, gelatin extracted from porcine based, and any Haram animals even being slaughtered in the name of Allah, is strongly forbidden. This interdiction is due to the DNA of porcine that remain unchanged even though it has undergone a series of chemical food processing. What has been stated in Al-Quran as Haram is Haram and there is no doubt of it.

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