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Gelatin: advantages and disadvantages of gelatin from plant and animal sources

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Abstract

Gelatin is a solid and transparent material that has wide application in various industries, especially for the production of food and pharmaceutical. This material is mainly made from meat, skin and bones of pigs and cows around the world. The industrial process of gelatin production is a long and costly process. It seems; these sources of gelatin production may be harmful to health. Therefore, this study was aimed at reviewing the alternative sources of gelatin production and the disadvantages and benefits of each of them. Relevant articles were searched from Google Scholar, Pub Med, Scopus, Science direct, and Cochrane library. According to the results of this article, gelatin with a source of animal can have many harmful effects on human health. While it is possible to produce good and useful gelatin using plant sources. Nowadays, from materials such as agar, pectin, carrageenan and konjac that are mentioned above, and as well as other materials, very good gelatins are prepared. And further researches are needed to find the rich sources of good gelatins or to find plants that have appropriate gelatin. In total, in gelatin, there are 18 types of amino acids, and of 10 amino acids needed for the body, 9 are in gelatin. In total, gelatin is introduced safe by the FDA.

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Introduction

Gelatin is a solid, transparent or semi-transparent substance, colorless, in (when it is dry) and more or less tasteless that comes mainly from collagen in the skin, flesh and bones of animals [1]. It is commonly used as a jelly agent in the food, pharmaceutical, photographic and cosmetic industries. Gelatin is mainly an unmodified hydrolyzed form of collagen in which the collagen protein is converted to smaller peptides and has a wide molecular weight range in relation to physical and chemical methods of denaturation based on what kind of hydrolysis process is used in gelatin production [2, 3]. Gelatin is used as a clearing agent in many beverages, volatile plasma, and stabilizer in many vaccines and in many other products. Gelatin is available in forms of

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sheet, granule or mainly powder [4-7]. Gelatin is a mixture of peptides and proteins that are made of collagen hydrolysis made from bone, skin, and connective tissue of animals such as pigs, cows, fishes, and chickens [8].

In 2016, worldwide gelatin production is reported to be around 400,000 tons per year [9]. Gelatin is a byproduct of the meat and leather industry and fish have recently been considered as one of its sources of production. Generally, the process of preparing gelatin from animal sources, that most important of which is the skin, flesh and bone of pig, lasts for several weeks [10-12]. In the pharmaceutical industry, gelatin is mainly used to make hard and soft capsules and also as a very useful material for the production of pills, emulsions, suppositories and syrups [13]. In total, gelatin is introduced safe by the FDA. Most of the amino acids needed in the body are present in gelatin and there are not just sulfur containing amino acids [14, 15]. Gelatin is also used in industries such as adhesives, military industries, banknote paper making, moisture absorption, and so on. Gelatin-based adhesives are used to attach two organic pieces, such as fruits and vegetables. Also in the textile industry, gelatin is used as a material for shining, coating, cotton, leather, silk and wool fulfillment [16-19].

The people of Rome have a lot of caution in taking gelatin because eating gelatin with a horse source is forbidden. In addition, many people around the world are vegetarians (Vegans) like many Hindus that do not use gelatin with an animal source, even non-vegetarian Hindus do not use cow gelatin [20-22]. So far, alternatives to animal gelatin such as agar, carrageenan, pectin, Konjac, etc. have been identified. The biggest problem with these gelatins that has not been able to replace them with animal gelatin has been the lack of cost-effective and unavailable sources of them [23].

It is also understood from this content that in the event of a state of emergency these prohibitions can also be permitted if the person is really in an emergency and does not exceed his limits and only consumes as much as it needs. So far, there have been many harms in the use of pork Including dysentery, infectious jaundice, a red wind like disease that appears in humans in the form of red and painful spots with intense burning on the hands, atherosclerosis, joint pain and poisoning that is due to the high amount of fat and uric acid found in pork and the occurrence of a variety of parasitic agents, including Entamoeba histolithic [24-31].

This research is a review and library study with focusing on interpretative texts and internet searches were performed by entering the keywords in the google scholar, PubMed, Magiran and science direct databases. The purpose of this study is to provide a variety of sources of gelatin production and examine them. We want to introduce vegetable and safe gelatin as a substitute for animal gelatin.

Background research

In 2013, Mariod et al. conducted a review of various types of gelatin and their sources for the presentation of various gelatins it was stated in this study that gelatins can be prepared from alternative sources such as fish except for animal [32]. Petrov et al., In a survey in 2015 to find out the properties of several types of gelatin for the manufacture of pharmaceutical capsules, concluded that the capsules prepared with collagen-derived gelatin had the highest concentrations (and only glycerol with water was added) while the lowest concentration was related to gelatin prepared from carrageenan [33]. In the 2013 Elzoghby review of the properties of gelatin as a carrier, especially for the production of carrier nanoparticles, gelatin was introduced as an important carrier of the drug as well as a substance used in gene therapy [34]. Bonilla et al. in 2016 examined a combination of gelatin and polysaccharide chitosan with several herbal extracts for their properties as food preservatives and showed that these compounds have antioxidant, antimicrobial and good preservative properties for all kinds of food [35]. In 2016, Al-Hassan determined the best properties of gelatin prepared from Greasy grouper fish in a study of gelatins derived from several types of fish as replacements for prohibited gelatins and even replacing animal gelatin. Also, all gelatins of fish origin, prepared in this study showed better properties than bovine gelatin [36].

Methodology

Relevant articles were searched from Google Scholar, Pub Med, Scopus, Science direct, and Cochrane library. In the first search we obtain 406 articles, 183 articles were excluded in first screening for duplication and inappropriation of their content (this step was done by study on abstracts). Finally, 55 articles were included that matched with our subject.

Animal gelatins

Animal gelatins are derived from animal sources, especially pigs, cattle, and animals such as fish and poultry but due to more economic efficiency, they are mainly made from pigs or cows. However, the process of preparing gelatin from animal sources is a long and costly process because the meat, skin, and bone of the animal must first be prepared, and then crushes into small pieces and subsequently extracted for several weeks by different processes with a large amount of different chemicals [37-39]. The mentioned operations are considered to be major disadvantages of animal gelatin in terms of industry because it takes a lot of time and money to prepare animal gelatin. Other great disadvantage of animal gelatin that, despite the vast efforts of companies and factories to keep it secret is the entrance of pathogenic and harmful agents from animal meat and body to gelatin and the harmful effects of these gelatins with unsafe sources on the human body, that in recent years it is becoming clear [40,41].

Swine gelatin

Swine gelatin is extracted from the skin, flesh, bone and connective tissues of the pig's body. The advantage of pig's gelatin is cost-effectiveness and the availability of its source and very high breeding [42].

Because of the pig's lifestyle, feeding and its biological structure, the amount of antibodies produced by the body of this animal is greater than the rest also; the amount of growth hormones produced in the body is greater than the body of other animals and humans. This high level of antibody and growth hormone naturally enters the muscle tissue of the pig; in addition, pork has a very high level of cholesterol, other lipids, and uric acid which can unsafe to humans [48-51].

Several allergic reactions including anaphylaxis due to the administration of intravenous injection of swine gelatin based plasma substitutes has been reported so far [52-61]. Allergic reactions have been identified after using varicella and MMR vaccines actually is due to the excipient that made of swine gelatin [62-64].

Bovine gelatin

Cow gelatin is also prepared just like swine gelatin, which has many of its properties and disadvantages. Bovine gelatin like swine gelatin has been used extensively and its source (meat and animal body) is why it still has a lot of mentioned risks especially. Several researches suggest allergic reactions to bovine gelatin due to the presence of bovine gelatin specific IgE and α-Gal [66]. Another very important problem is that Bovine Madness Agent (BSE) is easily transmitted from the cow body into its gelatin because this is a very persistent prion and in the case of gelatin made from meat and even more difficult conditions it can still be transmitted to gelatin [67].

Fish gelatin

Fish gelatin is made from fish skin and bone [68]. This type of gelatin also has its own limitations and complications including the fact that the source of it, that is, fish has not always been available everywhere, fish is also a valuable and expensive food, and it is not very economical to turn into gelatin [69]. Fish gelatin can also contain gelatin specific IgE and cause various allergies but it is much less than swine and bovine gelatin [70].

Vegetable and Seaweed Source Gelatins

Although in general, the word gelatin is referred to as a collagen-based jelly preparation made from animal tissues, but today, gelatin-like materials are prepared from vegetable sources with different formulations. They have very good properties; they are often very useful and not allergenic because almost all of them are made of safe and non-allergenic polysaccharides. If a suitable herbal source for the production of gelatin be discovered, herbal gelatinous products can be substituted for animal gelatins. Various researches on plant gelatins have proven their proper properties for the production of drugs [71-74]. Along searching for valuable plants such as figs, grapes, olives, cedrus and ocimum basilicum, there were not found any articles or studies on the extraction or preparation of gelatin in various Internet sources, while for example; ocimum basilicum has a high jelly agent which, if wet, secretes it out. During searches about pomegranate it was found that its skin is a good source for extracting pectin [74,57].

Agar

Agar is a jelly material like herbal gelatins. The agar is made mostly of polysaccharide agarose, which is a supportive material in the cell wall of some seaweed and released by boiling [75]. These algae are known as agarophyte and they belong to the red algae race. The gelatin agar in fact is made up of two materials: the first linear polysaccharide agarose and the second heterogeneous mixture of smaller molecules called agaropectin [76]. Agar has been used extensively for microbiological testing and culture media preparation it can be used as a laxative and also as an appetite suppressant. Most importantly, it has all the applications of animal gelatins [77]. Agar is a substance that is indigestible by most organisms so can make a good culture medium that will not be destroyed by the growth of microbes. Agar contains some minerals and vitamins, including calcium, iron, zinc, potassium, magnesium, folate and high levels of fiber. It can also be useful for weight loss in obese people [78]. In general, agar is considered as a healthy and beneficial gelatin that so far, no allergic reactions or adverse effects have been reported, but because of its laxative property is not suitable for people with diarrhea. Despite its high benefits, due to the lack of resources, it is less economically efficient.

Pectin

Pectin is a structural heteropolysaccharide found in the primary cell wall of terrestrial plants. Pectin is commercially available in the form of a white to brown powder and mainly extracted from citrus [79]. Pectin has all the applications of animal gelatin in addition, it is considered as a fiber source. Chemically, pectin is rich in galacturonic acid and its maximum amount is in premature fruit [80]. Pectin is in fruits such as pears, apples, peaches, plums, oranges and other citrus fruits, while there are a small amount of pectin in soft fruits like cherries, grapes and strawberries. About 30% of orange peel is composed of pectin, while the edible portion of the orange has a range of 0.5 to 3.5% pectin. And a soft fruit like cherry have about 0.4% pectin [81]. Most of the production of pectin is from orange peel and apple scum that both of which are side products in the production of juice. The pectin production process is much faster and easier than animal gelatin [82]. Pectin has a high positive effect on the intestines and excretion in human, it also has the ability to dispose of heavy metals from body. Pectin has good properties for drug production and now it is used to produce some medications such as pastille pills. The use of pectin by the World Health Organization and the American Food and Drug Administration is known safe [83].

Konjac

It is a plant from family Araceae and in Japan, China, Korea and Myanmar is cultivated a comestible plant. This plant also has a jelly agent called konjac gelatin and used as an alternative gelatin for vegetarians. About 40% of konjac gelatin is made from glucomannan [84]. This gelatin alone has many healing properties, including detoxification, tumor suppression, blood stasis alleviation, and smooth the phlegm [85]. The gelatin made from the konjac is free from calories and has high fiber content instead and that's why it's suitable for people with diabetes, obese people, diabetics and many other people. Nourishing konjac gelatin increases the production of butyric acid from normal intestinal flora and improves gut movements [86]. One of the problems with this gelatin is its edible size because the jelly is not digested in the human body and if children eat a large piece of it, there is a risk of choking. Konjac gelatin oral intake results in less IgE production and reduces the risk of dermatitis [87].

Carrageenan

Carrageenan is a family of linear sulfate polysaccharides made from edible red algae. Carrageenan is a very suitable gelatinizing agent in the food industry and due to the high binding power it has with proteins, it is used in dairy and meat products. It is not used due to health hazards and concerns in pediatric products and pharmaceuticals [88].

Conclusion

Our aim in this study was a comprehensive review of various types of sources, products and characteristics of different gelatins that in the near future, it will result in the production of gelatins with industrial and production advantages. Nowadays, from materials such as agar, pectin, carrageenan and konjac that are mentioned above, and as well as other materials, very good gelatins are prepared. And further researches are needed to find the rich sources of good gelatins or to find plants that have appropriate gelatin.In total, gelatin is introduced safe by the FDA. It is concluded that vegetable gelatin is safe and not allergenic and vegetable gelatin can replace animal gelatin.

Authors' contribution

All authors contributed equally to the manuscript.

Conflicts of interest

The authors declared no competing interests.

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