Research Progress of Bacterial Cellulose as Biodegradable Food Packaging Materials

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Abstract: With the emergence of environmental problems, suppliers of biodegradable food packaging materials predict that recycling regulations will lead to new requirements for environmentally friendly packaging materials. Biodegradable food packaging materials are closely related to consumers' interest in environmental protection products and are expected to become a new way for the domestic food packaging materials industry. All kinds of biodegradable food packaging materials with bacterial cellulose as raw materials have been published, and domestic and foreign enterprises are gradually increasing their interest in it. The biodegradable food packaging materials industry will have the potential of environment-related business market.
***Keywords*:** bacterial cellulose, biodegradation, food packaging, ecological friendliness

1. Introduction

Food packaging materials have made great contributions to the rich daily life of modern people and industrial development with diverse and excellent functions and low price[1]. However, the incineration of a large number of waste food packaging materials, the leakage of environmental hormones caused by landfill, the detection of highly toxic dioxins, and the air pollution caused by incomplete combustion of waste are becoming the causes of serious environmental pollution. In order to solve the waste problem of food packaging materials, the research on biodegradable food packaging materials is actively conducted, and the practical application of biodegradable food packaging materials is also on the rise.

Internationally, Germany, Italy, the United States and other advanced countries have mandatory requirements to use degradable resin in shopping bags and food packaging materials bottles[2]. Countries around the world are scrambling to strengthen environmental regulations, and governments are developing a policy to increase waste charges on existing products of generally stubborn food packaging materials. Therefore, the domestic food packaging materials industry is expected to face many difficulties, and these environmental regulations are expected to become an obstacle to the development of the existing food packaging materials industry.

Despite fierce international competition, there are new technologies and products with harmless additional functions, such as reducing volatile organic compounds, reducing environmental hormones and reducing carbon, in addition to biodegradability. In addition, in order to develop the domestic polymer food packaging material industry and reduce the environmental load, it is urgent to formulate a bill, due to the limitation of the physical properties and cost of biodegradable food packaging materials and the improvement of the physical properties and economic feasibility of existing products, the development and commercialization of oxidized biodegradable food packaging materials and bio-based food packaging materials are very active.

All countries in the world are accelerating the development of raw materials and products that are harmless to human body, easy to recycle, competitive in price and maintain the physical properties of existing food packaging materials[3]. In fact, in industry and academia, companies are developing hybrid and compounding technologies to complement and commercialize existing biodegradable products. Through these studies, a large number of eco-friendly materials, such as biodegradable food packaging materials, oxidative biodegradable food packaging materials, carbon reduction biological food packaging materials, have been on the market, some have entered the stage of practical use. Therefore, in order to explore the status quo of bacterial cellulose as a biodegradable food packaging material and prepare for the future, this paper summarizes the recent research and development, commercialization and market trends of bio-based food packaging materials related to raw food packaging materials.

2. Definition and category characteristics of biodegradable food packaging materials

2.1 Definition of biological substances

Biomass is a term combining organisms and quality, and is the concept of a specified amount of biological resources[4]. It is a general term for microorganisms and algae that fix carbon dioxide, microbial metabolites, chlorella, spirulina in the atmosphere through photosynthesis. The dictionary means an organism powered by plants or microorganisms that produces biomass similar to the earth's total oil reserves in a year, so if used properly, it is classified as an unlimited resource. In a broader sense, renewable organic matter derived from pure energy crops and trees, agricultural and feed crops, agricultural waste, forest waste, aquatic plants, animal waste, municipal waste and other waste.

Generally speaking, bioenergy refers to plant resources and microbial metabolites that fix carbon in the atmosphere through photosynthesis. However, as for the raw materials of industrial food packaging materials, the existing biodegradable food packaging materials all belong to the category of biomass sources. Cash crops are crops developed and created for the production of industry-specific chemicals, such as kenaf for fiber, straw and castor beans for ricin oleic acid. Crops are commonly used to produce sugar oils and a variety of extracts that can be used to make food packaging materials and other chemicals. Crops that contain ingredients from current circulating products and new products to be developed in the future include corn starch, corn oil, soybean oil, soybean meal, wheat starch and other vegetable oils

2.2 Definition of biodegradable food packaging materials

Biodegradable food packaging materials refer to bio-based polymers made from biomass and other biological resources, known as environmental protection food packaging materials, green food packaging materials, environmental protection food packaging materials[5]. Since biodegradable food packaging materials refer to all biomass-based food packaging materials, it includes non-biodegradable food packaging materials, which are closely related to global warming.

Since the main cause of global warming is believed to be carbon dioxide, there is a need for a new environmentally friendly material that can replace petroleum-based polymer food packaging materials, and with the emergence of the concept of carbon neutrality, biomobas-based polymers have been named as biodegradable food packaging materials. Carbon neutralization is the concept of using water, carbon dioxide and sunlight during the growing season, consuming carbon dioxide through photosynthesis in chloroplasts, and producing only the amount of carbon dioxide absorbed during the growing season, thus increasing the total amount of carbon dioxide on earth, which is discarded and decomposed in nature. More recently, biodegradable food packaging materials refer to polymers produced by chemical or biological refining processes using raw materials containing renewable materials such as carbon-neutral plant-derived sources. It has been used as an umbrella term for biomass-derived polymers.

2.3 Types of biodegradable food packaging materials

Biodegradable food packaging materials are polymers that reduce carbon emissions and harm humans, some of which include biodegradable food packaging materials. Degradable food packaging materials are the general term of biodegradability, oxidative degradability and photodegradability. Food packaging materials used for molding products, packaging materials, sanitary products, industrial products, agricultural products are not burned when discarded, but simply buried.

Fully decomposed food packaging materials such as gas. But in the disintegrating condition, it breaks down 200 to 300 years faster than existing refractory food packaging materials, compared to about 50 to 100 years in nature. In addition, bio-based food packaging materials often do not fall into the category of biodegradable food packaging materials because they focus on carbon reduction, rather than the category of biodegradable food packaging materials.

Food packaging materials are cut into a process that converts them into low-molecular weight compounds, which are eventually broken down into water and carbon dioxide. Among them, there are biodegradable food packaging materials as substitutes for food packaging materials, including the concept of using biomass for carbon reduction and oxidative biodegradation. If these categories of biodegradable food packaging materials are subdivided, first of all, there is a carbon reduction bio-based food packaging materials or biodegradable food packaging materials made by mixing kenaf, straw, wheat straw, rice husk, starch, corn husk, plant powder and other plant bodies with general food packaging materials. Two is the use of straw, wheat straw, sawdust, waste paper and other natural products pressed into shape, as well as the use of paper and pulp cellulose based products. Finally, there are oxidative biodegradable products using carbon-reducing plant biomass, universal food packaging materials, biodegradable resins, biodegradation promoters, oxidants and compatibilizers.

3. Research status of bacterial cellulose as biodegradable food packaging material

3.1 Research and development background of bacterial cellulose as biodegradable food packaging material

Bacterial cellulose is an excellent property and it offers a variety of alternatives as it is a potential substitute for food packaging materials. Bacterial fibers or nanocrystals have been the focus of most research as enhancers due to their high surface area, ability to generate new bond interactions, and their water insolubility. Low physical properties such as tensile strength and elongation have been pointed out as the limitations of existing biodegradable food packaging materials, poor processing; The final biodegradation period needs to be extended to prevent biodegradation within the shelf life;

Compared to general food packaging materials, excessively high prices and recycling difficulties have been raised, but products that compensate for these problems have been released in recent years. In addition, in the field of industrial application of biodegradable food packaging materials, products with improved physical properties such as processability and impact resistance are being launched one after another by adding biomass and oxidizing biological degradants to existing food packaging materials that are difficult to decompose. These products have excellent advantages over existing food packaging materials in terms of physical properties, processability and economic viability. Therefore, in the future, biodegradable food packaging materials using agricultural by-products, food factories and other industrial by-products, urban waste and other non-food organic waste resources will be used as future materials to solve the problems of price and strength, avoiding the use of starch and other food resources, is expected to be very popular.

3.2 Application of bacterial cellulose in food packaging

Although bacterial properties are suitable for food packaging or the food industry, these applications have not been fully explored and most research has focused on the biomedicine of these properties. Further studies are needed to determine mechanical properties, permeability, as well as interactions and release rates in semi-solid and solid food model media to assess potential applicability as active packaging. Bacterial cellulose /ε -polylysine in sausage packaging was detected, and the antibacterial effect of reducing the number of bacteria through storage time was observed. Bacterial cellulose /ε -polylysine formula can ensure food quality and prolong the shelf life of meat products.

Bacterial cellulose membranes rich in lactobacillin or post-biotics of lactobacilli also show good antibacterial properties and can be used for antibacterial packaging of processed and fresh meat products. Bacterial cellulose/post-biotic lactobacillus membrane is effective against Lactobacillus monocytogenes in fresh ground beef. Bacterial cellulose/Guar gum/polyvinylpyrrolidone/carboxymethyl cellulose films have been tested for packaging fresh berries. The blended polymer preserves the color and texture of the berries for up to 15 days. Bacterial cellulose coating can slow weight loss and improve fruit firmness, soluble solids content and titratable acidity.

3.3 Effective treatment of bacterial cellulose in food packaging

As a food packaging material, bacterial cellulose can make up for the shortcomings of the existing expensive biodegradable products, such as applicability and productivity reduction, and the difficulty of final biodegradation of photodegradable products. Therefore, countries in the world are actively promoting the development of technology in recent years. Bacterial cellulose as food packaging material is made by adding biomass, compatibilizers, biodegradation promoters and automatic oxidants to existing general food packaging materials.

Bacterial cellulose as a food packaging material is decomposed through a complex process of heat, light, microorganisms, enzymes and chemical reactions. Bacterial cellulose as a food packaging material is a concept including existing biodegradability, bio/ photodegradability and chemical decomposition, it is a new concept of biodegradable food packaging material, it uses the latest decomposition promoter, can control the final biodegradation period. At present, due to its controllable physical property, cost, decomposition cycle and other advantages, research and development and commercialization are on active status.

4. Conclusion

Consumers' growing interest in environmental protection has led to increased demand for the development of environment-related technologies and structural changes in the biodegradable food packaging materials, biomaterials and eco-packaging industries. Biodegradable food packaging materials are gaining increasingly interests in sustainability, it is a concept that encompasses all aspects of economic success, environmental protection and social welfare, as well as growing interest in environmental protection. In addition, consumers have put forward requirements for technological innovation of high-function packaging products such as miniaturization, lightweight convenience and mobility, and this change is a

positive factor for the packaging industry.

References

[1] Liu Xiaojing. Research progress of bacterial cellulose in packaging field[J]. *Packaging Engineering*, 2021,42(19):1-11.

[2] Zhao Dongmei,Chu Xiaoyu, Zhang Yong, Wei Lina, Jia Lianying, Liu Yu. Research progress of food packaging materials based on cellulose[J]. *Science and Technology of Food Industry*,2022,43(05):432-439.

[3] Zhang Guantao, Zhang Dongjie, Li Juan, Li Zhijiang, Wang Hongjiang, Mou Xiwang, Chen Guolong.Research progress on preparation and application of nanocellulose in food packaging materials[J]. *Science and Technology of Food Industry*, 2022,43(03):430-437.

[4] Sun Zhenbing, Li Xiaobao, Yao Yao, Tang Zhengjie, Li Xiaoping. Preparation and application of bacterial cellulose antibacterial composites[J]. *Packaging Engineering*, 2021,42(13):21-28.

[5] Chen Lu, Wang Jingjing, Zhao Yong, Dong Qingfeng, Liu Haiquan. Research and application progress of cellulose-based biodegradable bacteriostatic food packaging materials[J]. *Packaging Engineering*, 2021,42(05):1-12.