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REVIEW OF CORN STARCH BIOPOLYMER

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ABSTRACT

Corn or maize is a tropical grain plant, first domesticated about eight thousand years ago. Recently, the demand for corn has increased dramatically, for use in the production of various foods and edible oils, as well as the manufacture of biocompounds and biopolymers. Moreover, corn is very rich in starch which is one of the foremost copious and biodegradable biopolymers and is commonly utilized within the nourishment, pharmaceutical, textile, biomass energy, and chemical industries. Since the starch is completely biodegradable in a variety of environments and can allow the development of totally degradable products according to specific market requirements. The main objective of this review is to present a study on maize plants as a primary source of biodegradable polymers and fibre-based bio compounds with their applications.

Keywords: corn biopolymers, bio composites, physiochemical properties, starch

INTRODUCTION

The environmental pollution caused by petroleum-based packaging materials has become a serious problem in recent years [1]–[7]. Thus, the creation of materials that degrade faster in the environment has attracted considerable attention such as polylactic acid thermoplastic starch (TPS) [8]–[15], poly (butylene succinate) (PBS) [16], polycaprolactone (PCL), polylactide acid (PLA) [17], and polyvinyl alcohol (PVA) [18], [19]. Among renewable natural biodegradable polymers, starch is probably the most promising material due to its availability and low cost [20]–[22]. Biopolymers from various natural resources have been considered as attractive alternatives for non-biodegradable petroleum-based polymer, since they are abundant, renewable, inexpensive, environmentally friendly, as well as biodegradable and biocompatible [23]. The development and application of biodegradable starch-based materials have attracted increasing attention since well-known issues of oil shortage and an increased interest in environmental burden reduction due to the extensive use of petrochemical-derived polymers. Currently, more and more countries are introducing regulations and refusing to ban disposable plastic materials [24]. On the other hand, the study of the unique microscopic structures of different starches and their multi-stage transitions during heat treatment have increased basic knowledge of polymeric sciences, particularly for an understanding of the structure and treatment relationships and properties of polymers [25],[26]. Normally starch was extracted from sugar palm, tapioca, potato, corn, rice, and wheat, but recently discovered starch such as corn starch also possess comparable properties as biopolymer [27].

CORN PLANT

Recently, world maize demand has grown significantly, with total world maize production projected at 1.04 billion tons in 2014, which is equal to 31% of world cereal production [28]. Six types of corn plants have been named, flour, flint, pop, dent, pod, and sweet corn, which are vary significantly in physical and chemical characteristics. Dent corn is rightly called dent due to the dimple that forms in the center of the corn's grain [29]. Corn is mainly composed of one or more stems that emanates from a series of small roots. The stalk branches ended in inflorescences at each node. Corn plant contains after fully grown 15-20 nodes and a bamboo-like culm or stem that is joined in. In particular, the male and female flowers are born in structures known as the ear shoot and the tassel, respectively[29],[30]. Fig. 1 shows that main parts of the typical corn plant.

CORN STARCH

Due to its unique functional properties, lack of odor, low cost, and quality, corn starch is widely used in processed foods, pharmaceuticals, textiles, and paper products among others. Starch is used as a stabilizer and thickener of fluid foods in the food industry, due to its high viscosity, bland taste, and transparency of newly prepared starch pastes [31]. The corn plant is a great source of commercial starch available, with maize granules containing approximately 70% of the starch in addition to protein, oil, sugar, and ash [32]. Corn starch is a semi-crystalline polymer consisting of a mixture of linear polysaccharide amylose, and a highly branched polysaccharide amylopectin [33],[34]. Roughly more than 80% of world starch production is from corn, other important botanical sources of starch are, cassava, rice, wheat, and potato. Table 1 displays the approximate 2015 production of starch from different sources along with the estimated production of raw materials [35].

Corn starch granules consisting of linear amylose ranged between 20-28% and the rest of amylopectin [36]. Corn starch is widely used in grain processing industries, and it is a valuable ingredient used in applications in the food and non-food industries. Modified corn starch by genetic and physiochemical methods is widely used as a compound enhancement matrix. In addition to amylopectin and linear amylose, the chemical composition of cornstarch granules contains secondary components (proteins, lipids, and minerals) and the amounts of these components vary due to the botanical source [37].

APPLICATIONS OF CORN STARCH

Cornstarch is not only used as food for human and animal diets, it is also used in many industries. cornstarch products are widely used in tissues, corrugated fibreboards, stationery, paper bags, and other packing papers. It plays a crucial role in the paper and cardboard industry with different types of qualities and qualities because it is mixed in different steps of the manufacturing process [38]. Cornstarch is used in textile finishing processes to increase the hardness of the fabric to improve its appearance. It can act as a pattern for color inks when printing fabrics [39]. In the pharmaceutical industry, cornstarch is a major ingredient. It is used as a tablet binder and sugar-free ingredient in various products such as toothpaste, emulsifiers, lotions, liquid medicines and creams [40],[41]. Corn starch plays an important role in industrialization antibiotics, penicillin, blood wash solutions, vitamins, blood plasma alternatives as well as in drip-feeding systems. A number of lesser-known applications of cornstarch include the manufacture of amino acids, enzymes, yeast, and organic acids. Lactic acid, which is used in the manufacture of biodegradable polyester, made from starch. Many starch derivatives or other binary products have a number of applications in the food and drug industry [24]. At present, cornstarch has found more applications in the chemical and polymer industry. It is used in the manufacture of flocculants or surfactants for water treatment in water treatment plants, in the manufacture of polyols, which are used in the manufacture of polyurethane and other polymers that contain polyol [42],[43]. Cornstarch is often combined with other decomposers such as cellulose fibres, plasticizers, and decomposing polyester to make mostly environmentally friendly materials for temporary use such as hygiene, packaging and agriculture [44].

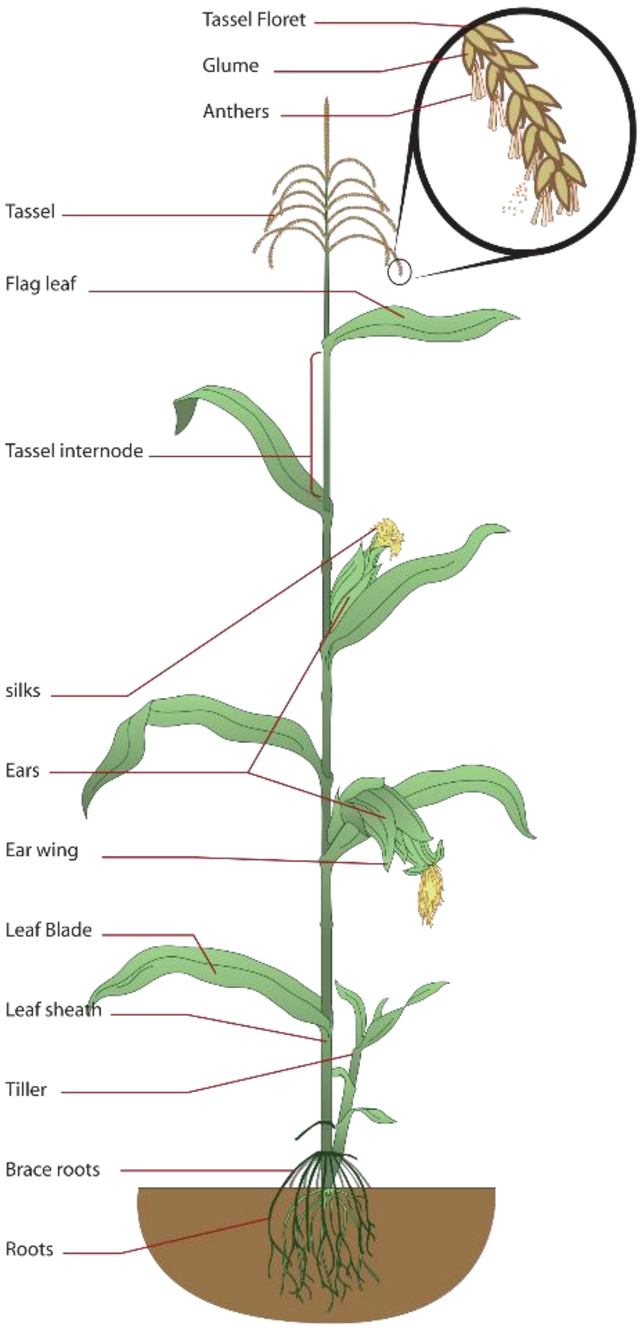

Fig. 1: Corn plant parts

CONCLUSION

Corn is an abundant and relatively inexpensive plant, moreover, corn is the largest commercially available starch source, and the second major source of biofuels. Therefore, corn compounds are widely used in a variety of applications. Starch extracted from corn grains provides some structural and functional properties such as the presentation of a large variety of halation, rheology, and energy swelling. A specific change in starch structure can be made to enhance the chemical, physical and enzymatic properties. Likewise, additional modifications to corn fibres are still required to improve the advantages of this type of fibre. Although many successful compound maize products were developed and modified, there was less progress in developing biomass compounds than maize compared to other natural compounds. Thus, more research must be done to reveal the importance of the biological compounds of the atom as well as to enhance its benefit to society.

Table 1. The production of starch and raw materials in the world in 2015 [35]

Production and uses	Corn starch	Cassava starch	Wheat starch	Potato starch	Rice starch
2015 Global production (million tons/year).	64.6	10.2	6	3.4	0.05
2011Global production of raw material (Million tons/year).	880	250	704	374	723

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