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Carbohydrate Polymers

SCIENTIFIC AND TECHNOLOGICAL ASPECTS OF INDUSTRIALLY IMPORTANT POLYSACCHARIDES

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CARBOHYDRATE POLYMERS

A Journal Devoted to Scientific and Technological Aspects of Industrially Relevant Polysaccharides

Aims and Scope

Carbohydrate Polymers covers the study and exploitation of polymers of sugars which have current or potential industrial application in areas such as bioenergy, bioplastics, biorefining, drug delivery, food, industrial chemistry, packaging, paper, pharmaceuticals, medicine, oil recovery, paper, textiles and wood.

Topics include:

- studies of structure and properties
- biological and industrial development
- analytical methods
- chemical, enzymatic and physical modifications
- interactions with other materials

The role of the carbohydrate polymer must be central to the work reported, not peripheral. At least one named carbohydrate polymer must be cited and be the main focus of the title of the paper, and of the paper itself. Research must be innovative and advance scientific knowledge.

Examples of papers which are not appropriate for *Carbohydrate Polymers* include:

- papers which major in biological, physiological and pharmacological aspects of non-carbohydrate molecules attached to, or mixed with, carbohydrate polymers;
- papers on the materials science of biocomposites where there is no mention of any specific carbohydrate polymer, or the role of the carbohydrate polymer is not central to the study.
- papers majoring on polyalkanoates, polylactic acid or lignin
- routine studies of extraction yields without characterisation of the extracted polysaccharide
- applications of new polysaccharides where the structure of the polysaccharide is unknown. (If a new polysaccharide is used to be acceptable the paper must include some structural characterisation of the polysaccharide in addition to the application studies Purity and monosaccharide composition are essential, some molecular size and linkage information is highly desirable.)

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Water absorption, retention and the swelling characteristics of cassava starch grafted with polyacrylic acid

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ABSTRACT

An important application of starch grafted with copolymers from unsaturated organic acids is the use as water absorbent. Although much research has been published in recent years, the kinetics of water absorption and the swelling behavior of starch based superabsorbents are relatively unexplored. Also, water retention under mechanical strain is usually not reported. Cassava starch was used since it has considerable economic potential in Asia. The gelatinized starch was grafted with acrylic acid and Fenton's initiator and crosslinked with N,N′-methylenebisacrylamide (MBAM). Besides a good initial absorption capacity, the product could retain up to 63 g H_2O/g under severe suction. The material thus combines a good absorption capacity with sufficient gel strength. The mathematical analysis of the absorption kinetics shows that at conditions of practical interest, the rate of water penetration into the gel is determined by polymer chain relaxations and not by osmotic driven diffusion.

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1. Introduction

1.1. General

Superabsorbent polymers (SAP) are materials which can absorb and retain a large amount of water or aqueous solutions. According to the Global Industry Analysts, Inc. report, it is projected that the world demand for superabsorbent polymers will reach up to 1.9 million metric tons in 2015. The fast increase in demand will be seen in the developing markets and in new applications (N.A., 2010). Superabsorbents were first developed in the US Dept. of Agriculture by grafting acrylonitrile (AN) onto corn starch and saponifying the product. Although at present superabsorbents consisting of fully synthetic polyacrylic acid dominate the market because they are cheaper to produce, research on starch-based superabsorbents is of growing interest again (Jyothi, 2010; Zohuriaan-Mehr & Kabiri, 2008). Waste disposal concern, increasing prices of petrochemical feed stocks as well as the desire to use renewable resources are driving this interest. To become more competitive, high water absorbency and higher gel strength are of great importance. The main incentive for our research project however was to find new applications of cassava starch. This is a renewable source of raw material which is abundantly available and relatively cheap in Asia, more specifically in Indonesia. Currently, the economic potential of cassava is not fully exploited which would make the development of possible industrial applications of particular interest (Witono, Noordergraaf, Heeres, & Janssen, 2012).

Superabsorbent materials consist of crosslinked hydrophilic polymer chains forming a 3-dimensional network structure. Both starch and vinyl monomers like acrylic acid, acrylamide, acrylonitrile and polyvinyl alcohol (PVA) are of interest as they contain a number of hydrophilic functionalities in their structure like hydroxyl and carboxyl groups. Ample literature reports and both older and recent patents (Chambers, 2010; Masuda, Nishida, & Nakamura, 1978) can be found on superabsorbent production based on starches, e.g. from wheat, corn or potato (Athawale & Lele, 2000; Athawale & Lele, 2001; Hashem, Afifi, El-Alfy, & Hebeish, 2005; Masuda et al., 1978; Qunyi & Ganwei, 2005; Weaver et al., 1977; Wu, Wei, Lin, & Lin, 2003). The use of cassava starch for this application is relatively novel since only few reports have appeared so far (Lanthong, Nuisin, & Kiatkamjornwong, 2006; Parvathy & Jyothi, 2012; Sangsirimongkolying, Damronglerd, & Kiatkamjornwong, 1999). Also, many papers deal with the indirect synthesis involving the grafting of starch with acrylonitrile or acrylamide followed by a hydrolysis reaction. Direct grafting of acrylic acid onto starch would eliminate the necessity of this second

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