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Production and characterization of starch nanoparticles by mild alkali hydrolysis and ultra-sonication process

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In this report, synthesis of the starch nanoparticles from underutilized and cheap sources viz: Horse chestnut (HS), Water chestnut (WS) and Lotus stem (LS) by using mild alkali hydrolysis and ultra-sonication process has been presented. The particles were characterized by Differential scanning colorimeter (DSC), X-Ray Diffraction (XRD), Rheology, Scanning electron microscopy (SEM) and Fourier transform infra-spectroscopy (ATR-FTIR). The particle size measurements, functional properties and antioxidant potential of starch nanoparticles were also analyzed. The experimental results revealed that the average particle size diameter of Horse chestnut starch nanoparticles (HSP), Water chestnut starch nanoparticles (WSP) and Lotus stem starch nanoparticles (LSP) was found to be 420, 606 and 535 nm, respectively. We observed a notable increase in the water absorption capacity but decreased capacity for oil absorption in the starch nano-particles. SEM images revealed damaged starch granules after size reduction. Additionally, loss of crystallinity and molecular order was observed from XRD and ATR-FTIR spectra. It was concluded that the starch nanoparticles have better thermal stability, increased viscosity and antioxidant properties.

Starch is a natural biopolymer, which is abundantly found in nature and also major component of our daily diet. It is mainly found in plant roots, staple crops and cereals such as rice, maize, wheat, barley, corn, tapioca, potato and others[1]. Starch is composed of linear chain molecule; amylose and branched chain molecule; amylopectin. These two starch components are assembled in the form of granules with the size ranging from 1 to 100 µm[2]. Starch has various applications, it has been used as thickening, gelling, stabilizing in a wide variety of foods and non-food products[3,4]. Starch is also used for drug and bioactive delivery systems[3,5,6]. The native form has however many limitations such as poor solubility, retro-gradation, limited digestibility and poor functional properties. For this reason, various physical, chemical and enzymatic methods have been employed to reduce these limitations or to add new attributes. Currently, starch nano particles are gaining more interest for improved quality and wide applications. They have been considered as the promising biomaterials for novel utilization in foods, cosmetics, and medicines as well as various composites[7]. There are various techniques for starch nano particle preparations including hydrolysis by acid, enzymes or combination of two, regeneration and mechanical treatments using extrusion, irradiation, ultrasound or precipitation by co solvent[3,8]. The easy and cost-effective methods for starch and starch derivative nanoparticles are always of paramount importance. Among various such methods, nano-precipation and ultra-sonication are very simple and reliable methods for nanoparticle production with desired size. The precipitation process involves a drop wise addition of a dilute starch solution into a non-solvent and ultra-sonication reduces the size by breaking the covalent bonds in polymeric material due to intense shear forces or mechanical effects associated with collapsing of micro bubbles by sound waves, it is simple, effective and environment friendly procedure[3,9,10]. Starch nanoparticles (SNP) were prepared by using ultrasound method without chemical additives from cassava, corn, yam and other sources of starch[3,11]. However the combination of physical and chemical processes produced nanoparticles with more desired properties[12]. So far starch from various sources like cereals, millets, tubers and others have been extracted and synthesized to nanoparticles[13–15], but the novel and cheap sources are of great importance from commercial point of view. Therefore, we selected the extraction of starch from crops like horse chestnut, water chestnut and lotus stem, as they remain mostly

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