Effect of concentration on rheological properties of media-milled cellulose

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Abstract

Cellulose is the most common organic compound on Earth. It is not digestible by human and is often referred to as ‘dietary fiber’ or 'roughage', acting as a hydrophilic bulking agent for feces. Nevertheless, the pliable but strong characteristics limit the applications of cellulose in food. Size reduction would be an attractive method to broaden the utilization of cellulose. Nano/submicron scale cellulose particles have been prepared by using media mill. The rheological behavior media-milled cellulose-suspension has been investigated using a dynamic rheometer.

Cotton cellulose, with a volume mean diameter 33.19 μm, was used as the raw material in this study. The diameter of cellulose was reduced to nano/submicron scale as determined by dynamic laser light measurement and illustrated by TEM. Both concentration and milling time affected the average particle size. In general, increasing milling time reduced the particle size. After being milled for 180 min, the highest concentration of 11% exhibited an average particle size (in volume) of 0.769 μm with the volume percentage of nano/submicron particles greater than 68%.

The viscosity of suspension increased with the concentration and exhibited shear-thinning behavior, which can be described by Williamson model. The milling resulted in viscoelastic solid properties when the content of cellulose was 5 to 11%.

Nevertheless, for low concentration of 1 and 3%, the suspension exhibited viscoelastic fluid behavior. The results showed that the size reduction to nano/submicron scale induced changes in rheological properties.