



Development and Physicochemical Properties of Modified Corn Starch with Soy Protein Isolate

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Abstract

Corn starch has been widely used in food, chemical, textile and building materials industries. In this paper, corn starch were modified with soy protein isolate, then the product of starch interacted with soy protein isolate (pro-starch) were prepared in different processing conditions to produce different starch-protein samples. The physicochemical properties of the product have been studied as well. We also analyzed the effect of silty tensile properties with the five percent of the sample added to wheat flour. The results are as follows: RVA analysis indicated: compared to untreated corn starch, the PT, PV, MV, FV, SB, FB of CS/SPI samples reduce obviously. The FTIR spectra and SEM data showed that: There was an obvious peak appearance nearby the ester carbonyl C=O stretching vibration peak nearby 1732 cm⁻¹ on the spectra, that produced a new type of modified starch which maybe have an esterify cross linking.

Keywords: Corn starch; Soy protein isolate; Physicochemical properties; FT-IR

Introduction

The shear strength and retro gradation of corn starch are strong, and the stability is good. To corn starch, hydroxyl can be combined with water molecules to form a hydrogen bond, which is a binding state, and has the ability to absorb moisture. Therefore, the starch molecules do not appear to be moist, although they contain lots of water. When the corn starch milk is heated to above 55°C, the starch molecules will absorb water and the molecular volume will increase, and the molecular structure will not change substantially. Starch gelatinization interacts with water molecules and swells and splits. With the increase of temperature, starch milk begins to gelatinize, the starch granules become more transparent and the viscosity becomes significantly larger. Because the untreated corn starch has the disadvantages of its molecular structure and function, it seriously hinders its use in the industrial production and processing field. Therefore, in order to further improve the processing performance of CS and broaden the scope of its use, on the basis of its own properties, people use high temperature, radiation, reagents, enzymes and other physicochemical and biological treatment methods to rearrange the starch molecules. Cutting or other operations or the introduction of new groups between molecules, in order to change the nature of its molecules, thus increasing the functional properties of the starch molecules, may also introduce other characteristics of the molecules, which has been modified starch. For the natural macromolecule polymers, starch and protein are also the main nutrients in food production and processing. They are inexpensive, easily degraded and have good biocompatibility. Their unique molecular structure and functional properties are also good for production. Functional characteristics and important internal factors of the texture product. Studies have shown that starch-protein complexes exhibit some unique properties due to the interactions between starch and proteins. In this experiment, soybean starch and corn starch were used as raw materials, and corn starch was modified by dry heat treatment, and its physical and chemical properties were studied.

Materials and Methods

Materials and reagents

Corn starch and soy protein isolate, Zhengzhou Boyan Biotechnology Co., Ltd. Sifeng Shantou special flour, Xinxiang Sifeng flour Industry Co., Ltd.; Citric acid (Analytical Pure), Hongyan Reagent Factory, Hedong District, Tianjin [1].

Methods

Sample preparation: Slowly add 100 g of distilled water to 3 g of soy protein isolate and stir

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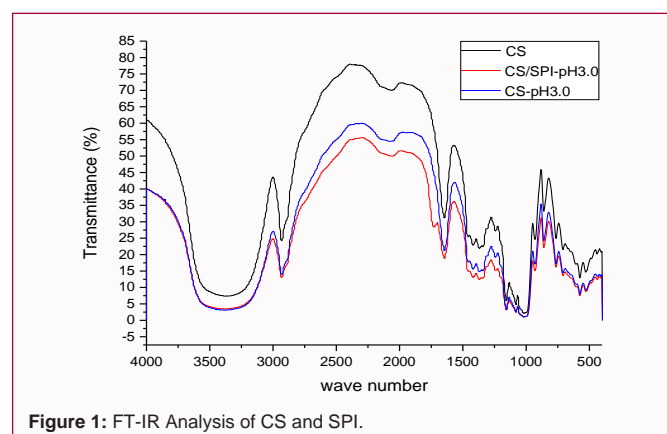


Figure 1: FT-IR Analysis of CS and SPI.

vigorously. After the soy protein isolate is completely dissolved (pH 6.8), 80 g of corn starch is dispersed in the solution of the soy protein isolate, and the pH of the starch protein mixture is adjusted to 2.5, 3.0, and 3.5 by using a citric acid solution having a mass fraction of 50% and then use a magnetic stirrer to disperse and stir for 1hr at room temperature [2]. The dispersion was transferred to a magnetic disk or glass dish and placed in a drying oven for drying. The oven was kept at a constant temperature of 45°C until the sample had a moisture content of less than 10%. The mixture of dried starch and soy protein isolate was ground to a powder and passed through a 100 mesh screen. The CS/SPI mixture was heated in an oven at 130°C for 1 h, washed and refined, dried at 45°C to a moisture content of less than 10%, ground into a powder and passed through a 100 mesh screen to obtain a starch-protein modified sample [3].

Determination of CS/SPI paste properties: Measure 25 mL of distilled water and transfer it to a dry, clean RVA sample cartridge. Transfer 3 g of starch or a mixture of starch and soy protein isolate (according to 14% wet basis) to the sample cylinder. Place the stirrer in the sample cylinder and stir it up and down 10 times. Disperse the sample. The samples were stored at 50°C for 1 min, then heated to 95°C at 12.0°C/min and kept at 95°C for 2.5 min. Afterwards, it was cooled to 50°C within 2.5 min and then kept at 50°C for 2 min. The whole measurement process went through 13 min. During the analysis of the entire gelatinization characteristics, in addition to the first 10s required to disperse the starch sample with 960 r/min stirring, the constant paddle rotation speed was maintained at 160 r/min, and the starch and starch-protein mixture was used in the gelatinization process using analysis software. Viscosity curves in the sample and the parameters of the sample: gelatinization temperature PT, peak viscosity PV, lowest viscosity MV, final viscosity FV, attenuation value BD, retrogradation value FB.

Fourier transform infrared spectroscopy: Using dry potassium bromide crystals or powder as the substrate, take 1 mg of the sample and about 100 mg of potassium bromide in an agate mortar to grind into a uniform powder, and pour the ground mixture into the mold

slowly. The sample was pressed into a thin sheet under pressure, the sample sheet was taken out, put into a sample holder, and placed in a Fourier infrared spectrometer to scan in the range of 4000-400 cm⁻¹, and the infrared spectrum of each sample was recorded.

Results and Analysis

CS/SPI paste analysis

The viscosity index of different starch/protein samples is shown in Table 1. From the data in the table, it can be found that the gelatinization temperature of processed corn starch and soy protein isolate is advanced compared to that of untreated corn starch. When the pH was adjusted to 3.0 and 2.5, the starch-protein sample did not show a gelatinization temperature in the assay analysis report, indicating that it did not substantially gelatinize. After citric acid was adjusted to pH 3.0, the gelatinization temperature of corn starch was reduced by 1.7°C. Compared to untreated corn starch. The peak viscosity TV, the lowest viscosity MV, the final viscosity FV, the attenuation BD, and the recovery FB of the acid-treated CS samples all decreased to varying degrees compared to the untreated CS. For starch-protein samples, the lower the acid treatment pH, the lower the corresponding TV, MV, FV, BD, and FB values [4].

Fourier transforms infrared spectroscopy

With the selective absorption of different functional groups of organic compounds in the infrared region, corresponding qualitative analysis of organic functional groups and structures can be made, which is of great significance for structural analysis of various modified starches. Figure 1 shows the original FT-IR spectra of starch-protein samples and raw corn starch. From the infrared spectrum of the sample in Figure 1, it can be seen that starch-protein samples have strong absorption peaks near 3390 cm⁻¹, 2940 cm⁻¹, and 1160 cm⁻¹. These three are the association stretching of -OH. Vibrational absorption peak, asymmetric stretching vibration absorption peak of -CH 2- and asymmetric stretching vibration absorption peak of C-O-C bond, peak appearing at 1646 cm⁻¹ belongs to two -OH of water molecules absorbed by starch. The absorption peaks formed by shearing vibration, 570 cm⁻¹, 750 cm⁻¹, and 860 cm⁻¹, are the characteristic vibration absorption peaks of -CH₂. The above peaks belong to the characteristic absorption peaks of untreated corn starch. The IR spectra of the starch-protein samples were studied and it was found that the interaction between the untreated corn starch and the soy protein isolate did not destroy the basic structure of the original corn starch molecules. However, protein-starch clearly showed a stretching vibration absorption peak of carbonyl C=O at 1732 cm⁻¹, which was not found in the original corn starch and soybean protein isolate protein.

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Table 1: Paste Analysis of CS and SPI.

Sample	PT/°C	PV/(mPa·s)	MV/(mPa·s)	FV/(mPa·s)	BD/(mPa·s)	FB/(mPa·s)
CS	76.4	3647	2369	3522	1278	1153
CS-pH3.0	74.7	476	68	130	395	62
CS/SPI-pH2.5	-	65	63	92	2	29
CS/SPI-pH3.0	-	177	94	162	79	64
CS/SPI-pH3.5	76.3	2272	1427	2064	845	637

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