Title:

Enzymatic Hydrolysis and Fermentation of Soy Flour to Produce Ethanol and Soy Protein Concentrates with Increased Polyphenols

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Introduction:

Soybean carbohydrates, which make up to 30% of soy-flour, go unutilized when manufacturing soybean-protein-concentrates (SPC). About half of these carbohydrates are composed of water-insoluble celluloses, hemicelluloses and low-methoxy-pectins, and remain in the protein matrix after the soluble carbohydrates are extracted by ethanol in traditional SPC manufacturing practice. These carbohydrates do not bestow any nutritional benefit; instead, they lower the applicability of SPC as a functional protein ingredient. Furthermore, isoflavones, which are polyphenols associated with various health benefits, are drastically reduced during traditional manufacturing of SPC.

In this study, SPC with increased polyphenols was obtained by isoelectronic precipitation during which insoluble carbohydrates were hydrolyzed by a cellulase-blend into simple sugars which were simultaneously fermented by *Saccharomyces cerevisiae* to produce ethanol as a coproduct.

Methods:

Soy-flour-slurry (pH 4.8, 20% w/v) was inoculated with *Saccharomyces cerevisiae* and a cellulase enzyme-blend, which contained cellulases, β-glucosidases and hemicellulases. Fermentation was performed under microaerophilic conditions (32°C, 150 RPM in orbital shaker, 24 h) along with a control and an enzyme-blend-only run. Fermentates were centrifuged (3,200×*g*, 25°C, 35 min) to obtain SPCs and liquid hydrolysates. Soluble carbohydrates and ethanol content of hydrolysate, protein content of freeze-dried SPC and polyphenol content of fermentate and SPC was analyzed.

Results:

SPC from fermentation contained 62.5% d.b. protein, which was more than enzyme-blend-only SPC (60.6%) but lesser than control SPC (63.9%). However, this SPC also contains yeast protein, which ought to bring flavor and functional changes to this ingredient. Total soluble carbohydrates in enzyme-blend-only hydrolysate (76.7 mg DE/g soy-flour) were 68.7% more than control, and were subsequently reduced by 84.6% (11.2 mg DE/g soy-flour) in cellulase+yeast run. 45.2 mg ethanol/g of soy-flour was recovered from its hydrolysate, as yeast fermented the sugars. Total polyphenol in cellulase+yeast's fermentate (2.80 mg GAE/g soy-flour) was similar to enzyme-blend-only (2.73 mg GAE/g soy-flour), and was 25.6% more than control (2.23 mg GAE/g soy-flour), and its SPC (2.41 mg GAE/g SPC) had 37.2% more polyphenols than control (1.75 mg GAE/g SPC).

Significance:

A novel process was developed for producing SPC with yeast proteins, reduced water-insoluble moieties as carbohydrates, increased polyphenols, and more bioavailable isoflavones.