Physicochemical Properties of Chemically Modified Bean Starch

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Starch is a macromolecular complex of at least two polymeric components, amylose and amylopectin, namely a linear and a highly branched $\alpha$-D-glucan present in the ratio of $\sim$1:3, respectively. Both of the polymers are essentially 1,4-linked, with the latter in addition having 1,4-linked branches attached to the main chain by 1,6-linkages. Starch is modified to improve the end-use applications. Oxidized starches are used as coating and sealing agents in confectionaries, as emulsifiers and dough conditioners in bread, and as binding agents in batter. Starch acetates are derivatives of starch obtained through esterification. In acetylation, hydrophilic hydroxyl groups are substituted with hydrophobic acetyl groups. The objective of this study was to investigate the effects of oxidation and acetylation on physicochemical properties of starch isolated from bean.

Starch was extracted from black and pinto beans by wet milling and centrifugation. A portion of each extracted starch was acetylated or treated with ozone gas. The degree of oxidation was measured by determining the amount and distribution of uronic acid in the starch. The degree of acetylation was measured using $^1$H-NMR. The physicochemical properties of the control and modified bean starches were evaluated by measuring the starch gelatinization as well as the amylopectin chain length distribution and starch digestibility. Bean starch gelatinization was determined by differential scanning calorimeter \cite{1} and a rapid visco analyzer. The starch swelling volume and storage stability was measured \cite{2}. The in vitro digestibility of the starch was determined using the method of Englyst et al, 1992 \cite{3}. Analysis of variance was performed, with alpha of 0.05, using SAS software and F protected least significant difference was done to determine mean separation.

Chemical modifications applied bean starch creates significant changes in the physicochemical properties. Uronic acid was found only in the amylose of the control bean starch but was found in both amylopectin and amylose of ozonated bean starch. Acetylated black and pinto bean starch had significantly lower ($P>0.05$) pasting viscosity than control or ozonated bean starches. The peak gelatinization temperature for the acetylated bean starches was approximately 65°C and was above 74°C for all other bean starches. Acetylated bean starches had significantly ($P>0.05$) wider gelatinization temperature ranges than the other bean starches. Acetylated black and pinto bean starches had better gelling capacity and gel stability. The acetylated starch also had a significantly different ($P>0.05$) starch digestibility profile than the other starches. The rapidly digestible starch, slowly digestible starch, hydrolysis index and estimated glycemic index was significantly lower ($P>0.05$) in the acetylated starches. The acetylated bean starches had approximately 12 percent rapidly digestible starch, and other bean starches ranged from 22 to 25 percent. The estimated glycemic index for the acetylated black and pinto bean starch was 70.89 and 73.55, respectively and ranged from 126 to 134 for the other bean starches. In conclusion, the ozonation of black and pinto bean starch results in an increase in the amount of uronic acid, which is more evenly distributed in the starch. The gelling capacity and stability of the black and pinto bean starch was improved after the acetylation of the starch. The acetylation of the bean starch also reduced the amount of rapidly digestible starch and the estimated glycemic index, which has positive health benefits.

REFERENCES

