Shear-thickening behavior exhibited by gelatinized dispersion of 10% of waxy corn, waxy potato, waxy rice and waxy wheat starches between 1-100 s⁻¹ shear rates was investigated in this study. Gelatinized waxy corn and potato starch dispersions exhibit shear-thickening behavior around 20 s⁻¹, a phenomenon that was not observed in gelatinized waxy wheat and rice starch dispersions, nor normal starches. Shear thickening behavior may have some implications on delaying gastric emptying time. Thus, in order to improve shear-thickening behavior of starch for potential nutrition advantages the shear thickening was enhanced with the use of hydrocolloids. Starches were mixed with various hydrocolloids following gelatinization and their rheological properties were studied. In simulated gastric juice, potato and waxy potato starch dispersions showed continuous increased viscosity; the viscosity of waxy corn starch firstly increase, following a decrease of viscosity up to 0.05 Pa·s, whereas the viscosity of corn starch dispersions decreased over test.

However, irreversible shear-thickening behavior is also observed in waxy corn starch paste at low shear rate (1-100 s⁻¹). Shear-thickening, smooth or discontinuous, is an increase in viscosity with increasing shear rate which is observed in a variety of complex fluids containing polymeric molecules. Although starch molecules can re-entangle after the shear rate is stopped, the original structure is not capable of full recovery in a short time.

Shear-thickening behavior of Gelatinized Starch Dispersions and its Potential Effects on Delay in Gastric Emptying Rate

INTRODUCTION

After gelatinization, entanglement of starch molecules can be induced, resulting in the formation of a network structure in solution that increases the viscosity of these materials with decrease of temperature. The network structure can be altered by shear forces leading to a reduction of the viscosity. Effects of breaking intra- and inter- molecular hydrogen bonds and unraveling molecular chain entanglement have resulted in shear-thinning behavior of gelatinized waxy starch dispersions.

Flow ramp tests have resulted in shear-thinning behavior of gelatinized waxy corn and potato starch dispersions; whereas the viscosity of corn starch dispersions decreased and the viscosity of waxy corn starch firstly increased following by a decrease.

RESULTS

Fig. 1 Shear recovery tests of gelatinized waxy corn, potato, wheat and rice starch dispersions

Fig. 2 Effects of hydrocolloids on 10 wt. % gelatinized waxy potato starch dispersions

Fig. 3 Effects of hydrocolloids mixture on 10 wt. % gelatinized waxy potato starch dispersions

Fig. 4 Cyto-SEM Images of gelatinized starch dispersions

Fig. 5 Viscosity of gelatinized starch dispersions in simulated gastric juice

CONCLUSIONS

1. With addition of agar and xanthan gum, the viscosity of gelatinized waxy corn and potato starch dispersions decreased with increased shear rate with no shear-thickening behavior.
2. The addition of pectin, sodium alginate or guar gum had no effects on shear-thickening behavior but altered the overall viscosity of the dispersions.
3. However, upon addition of gum arabic, shear-thickening behavior was more obvious and moved to higher shear rates.
4. In simulated gastric juice, potato and waxy potato starch dispersions showed continuously increased viscosity, whereas the viscosity of corn starch dispersions decreased and the viscosity of waxy corn starch firstly increased following by a decrease.

These studies indicated that gelatinized waxy potato starch dispersion has a potential to increase and delay the gastric emptying rate compared to waxy corn starch. Results of this research should help to understand how rheological properties of starchy foods affect the digestion process in terms of gastric emptying.

FUTURE WORK

1. Mechanism of shear-thickening behavior
2. Application of shear-thickening behavior of gelatinized starch dispersions on delay in gastric emptying time

REFERENCES