

## PHYSICOCHEMICAL PROPERTIES OF STARCH-MALTODEXTRIN AND STARCH-MALTODEXTRIN-GLUCOSE SYSTEMS

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### ABSTRACT

Starch is a widely used food additive. The addition of other ingredients changes the physical properties of resulting systems. The aim of this study was to investigate the rheological characteristics and susceptibility to retrogradation of starch-maltodextrin and starch-maltodextrin-glucose systems. Flow curves of 5% starch - maltodextrin and starch-maltodextrin-glucose pastes were tested by using rotational rheometer. The susceptibility to retrogradation of 2% pastes starch-maltodextrin and starch-maltodextrin-glucose systems by means of turbidimetric method was evaluated. It was found that all samples (systems) were a non-Newtonian, pseudoplastic fluids, with tend to the yield stress. Moreover addition of low and high DE maltodextrins and glucose to the starch caused a decrease in the values of shear stress throughout whole shear rate range. Starch pastes with greater concentration of the maltodextrins had less tendency to retrogradation. Also addition of glucose to starch-maltodextrin systems reduce the susceptibility to retrogradation.

**Keywords:** starch, maltodextrin, glucose, flow curves, retrogradation

### INTRODUCTION

Both starch and maltodextrin have different functional properties. Alone it creates pastes with specific properties. However, by mixing the two substances, the obtained product may have different physicochemical properties. Maltodextrins are partially hydrolyzed starch products. They are commonly characterized by their degree of hydrolysis, expressed as the dextrose equivalent (DE), which is the percentage of reducing sugar calculated as dextrose on dry-weight basis (Marchal *et al.* 1999).

Starch and maltodextrin are commonly added to many food products, because they give specific characteristics to the final product, among others properties of stabilizers or thickeners the product. Interaction of these mixtures with other food ingredients are not exactly known, and therefore this kind of research is carried out.

The aim of this study was to investigate the rheological properties of starch systems with commercial low and high DE maltodextrins and glucose.

### MATERIAL A METHODOLOGY

The material consisted of potato starch (from „PEPPEES S.A.” Łomża, Poland), low DE (DE=10,7) and high DE (DE=23,9) maltodextrins (from „PEPPEES S.A.” Łomża, Poland) and glucose (POCh Gliwice, Poland).

The study was carried out on systems: 90% S + 10% ML; 90% S + 10% MH; 80% S + 20% ML; 80% S + 20% MH; 70% S + 30% ML; 70% S + 30% MH; 89% S + 10% ML + 1% G; 89% S + 10% MH + 1% G; 79% S + 20% ML + 1% G; 79% S + 20% MH + 1% G; 69% S + 30% ML + 1% G; 69% S + 30% ML + 1% G, where S – mean starch, ML – low DE maltodextrin, MH – high DE maltodextrin, G- glucose and number- participation of component in pastes.

In this paper the symbol MD labeled maltodextrin (low and high DE together).

By means of turbidimetric method, according to Jacobson (1997), the susceptibility to retrogradation of 2% pastes starch with maltodextrin and pastes starch-maltodextrin-glucose was evaluated. The studies were performed at 4 and 20°C.

The rheological measurements of the samples (5% pastes) were carried out with the rotational rheometer Rheolab MC1 (Physica, Germany). The coaxial cylinder (cup diameter: 27,12 mm, bob diameter 25 mm) were used as a measuring system. The flow curves at the temperature 50±1°C were obtained in the range of sheare rate from 1-500s<sup>-1</sup> by 3 minutes; next samples were obtained in constans of sheare rate 500s<sup>-1</sup> by 2 minutes, and finally pastes were obtained in the range of sheare rate from 500-1s<sup>-1</sup> by 3 minutes. The control of the rheometer were carried out using US 200 software (Physica, Germany).

### RESULTS AND DISCUSSION

Retrogradation of gelatinized starch is a reorganization process which causes changes mainly in the structure of amylose. This phenomenon is often unfavorable in the food industry.

In this study differences in the initial turbidities of the analysed systems S-MD and S-MD-G both in 4°C i 20°C were observed. Higher the initial turbidities characterized samples with content of maltodextrin low and high DE. Samples containing 90% starch already on the 3rd day of storage showed a significant increase in turbidance, which subsequently continued to grow significantly during next days. Until on 7<sup>th</sup> day it was observed a slight increase in turbidance for samples with 20% and 30% maltodextrin (fig.1.). In studies Sobolewska-Zielińska and Fortuna (2010) it was concluded that the addition of low levels of maltodextrins to food products may prevent the retrogradation of starch to some extent.

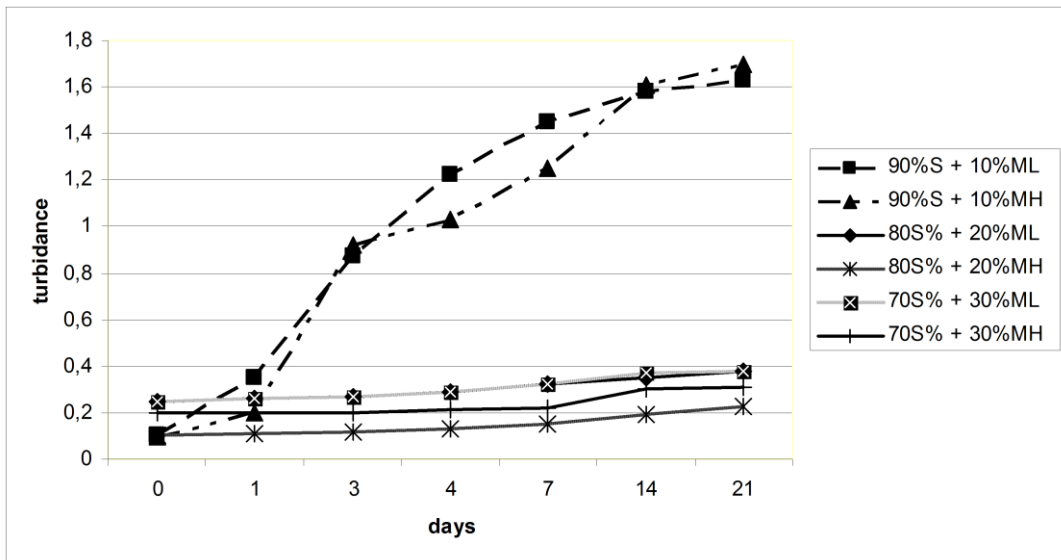


Figure 1 The susceptibility of systems S-ML and S-MH to retrogradation at 4°C

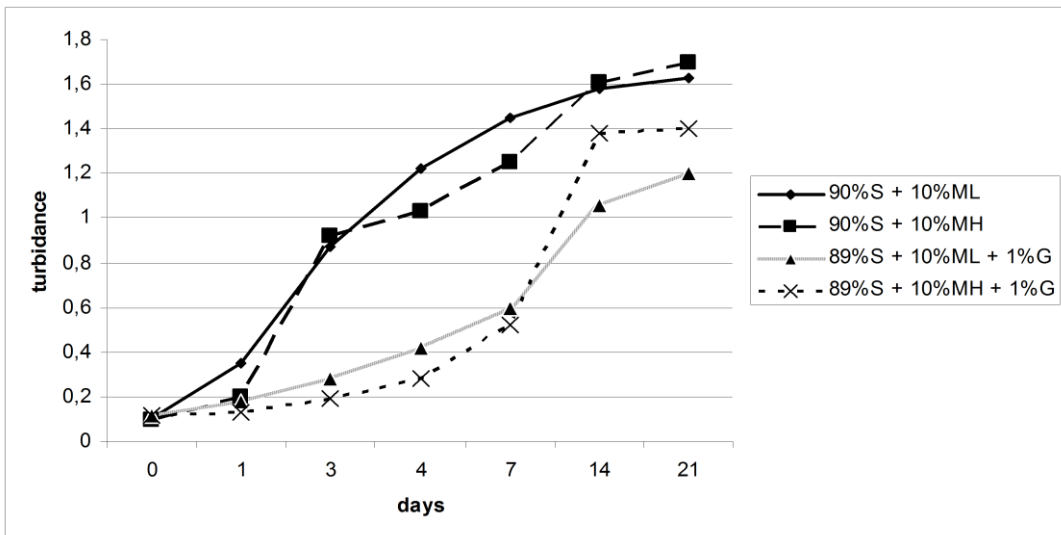


Figure 2 The susceptibility of systems S-ML and S-MH with and without glucose to retrogradation at 4°C

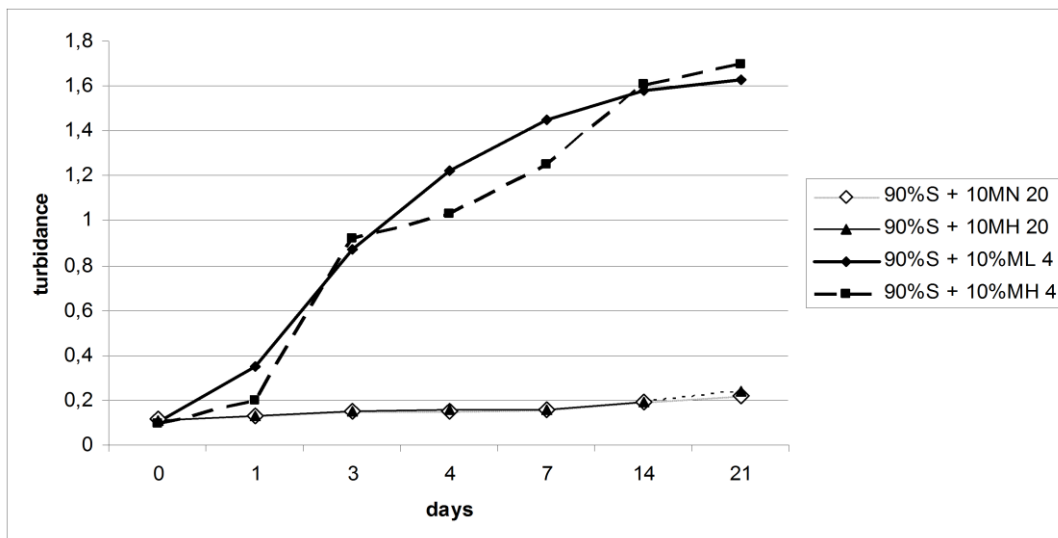


Figure 3 The susceptibility of systems S-ML and S-MH with and without glucose to retrogradation at 4°C and 20°C

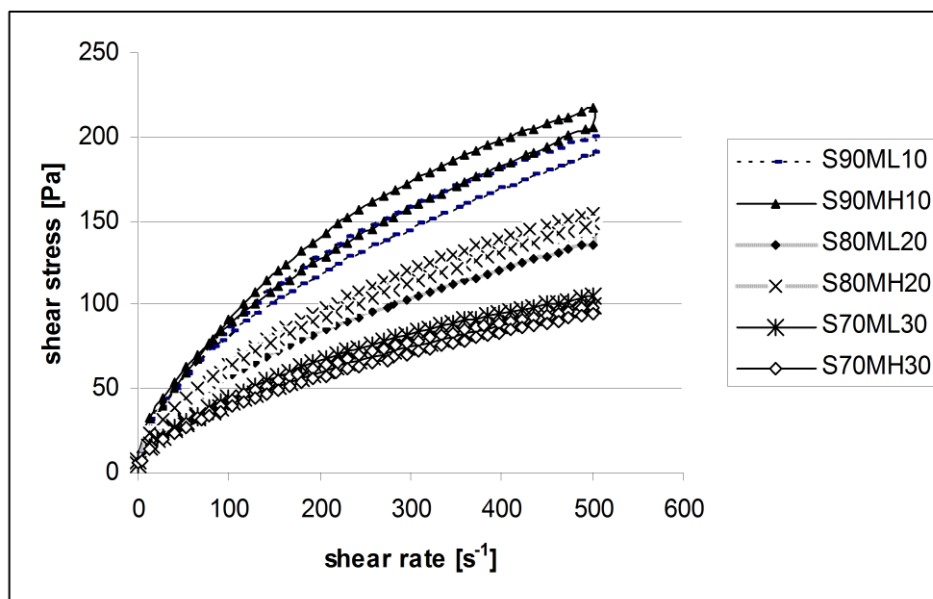


Figure 4 Flow curves of pastes starch with low and high DE maltodextrins

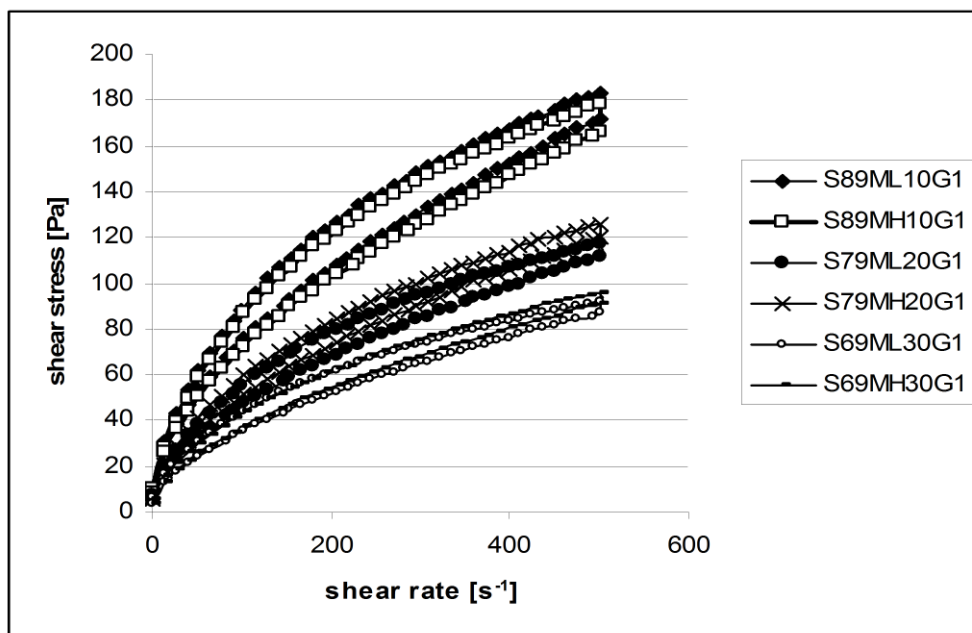


Figure 5 Flow curves of pastes starch with low and high DE maltodextrins and glucose

Addition of 1% glucose resulted in reduction of turbidance of systems S-MD. The increase in turbidance on days 1-7 was not so fast as for samples without glucose. Turbidance on the last day of the test (21 days) of samples with the addition of glucose was also significantly lower than for samples without additive glucose. This is shown in figure 2 for pastes of systems 89%S+10%MH+1%G and 89%S+10%ML+1%G. Studies of other authors indicate, that sugars (glucose, fructose, maltose) inhibit retrogradation of rice and potato starch (Chang & Liu 1991, Katsuta et al. 1992).

The most common flavors that are added to starch products are sucrose, glucose, lactose or fructose. The addition of these substances affects the viscoelastic properties of starch. Viscoelasticity of starch pastes greatly

depends on the origin of starch, starch concentration and kind of sweet substances (Hirashima et al. 2005). The results of measurements of rheological properties of 5% pastes S-MD and S-MD-S was shown in figure 4 and 5. All tested pastes were non-Newtonian, pseudoplastic fluids with yield stress. This character is typical of starch pastes, which is confirmed by studies on natural starch and modified starch (Al-Malah et al. 2000, Gruchala et al. 2000, Yoo & Yoo 2005). With the increasing participation of low-DE and high DE maltodextrins in pastes S-MD system shear stress values gradually decreased. The highest values of shear stress at the maximum shear rate it was observed for the system with the highest content of starch 90%S+10%ML i 90%S+10%MH (fig. 4.). Systems with the addition of ML and MH (in the same

concentration) differed slightly from each other in the whole range of shear rates.

Addition of 1% glucose contributed to the further reduction of the shear stress for system S-ML and S-MH. These conclusions are confirmed by the literature data (Fortuna and Galkowska 2006). The lowest values of this parameter in the whole range of shear rates were observed for samples 69%S+30ML+1%G and 69%S+30MH+1%G (fig.5.).

### CONCLUSION

1. Starch pastes with greater percentage share of the maltodextrins had less tendency to retrogradation.
2. Addition of glucose to starch-maltodextrin systems slowed down the process of retrogradation.
3. The most susceptible to retrogradation S-MD and S-MD-G pastes were these with the largest percentage of share starch and stored at 4°C. The pastes stored at 20°C did not reach as high turbidance as pastes stored at 4°C.
4. All tested samples were a non-Newtonian, pseudoplastic fluids, with tend to the yield stress.
5. Addition of maltodextrins and glucose to the systems caused a decrease in the values of shear stress throughout whole shear rate range.

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