

# Abstract

## **Rheo-unstable properties of the potato starch pastes and the possibilities of their stabilization by non-starchy hydrocolloids**

The aim of this thesis was to obtain pastes of normal and waxy potato starches (NPS and WPS) with different rheological properties and to study their thixotropic properties depending on the concentration and the pasting temperature of the starch. The study was also carried out on the mixtures containing starch and non-starchy polysaccharide hydrocolloids (NPH), e.g. guar and xanthan gum. The useful goal was an attempt to stabilize the rheological properties of the potato starch pastes by adding the appropriate NPH, which aimed at the conversion of the blends to a degree of structure recovery at 100 %.

Amylose, fat, phosphorus content, molecular weight and polydispersity, water binding capacity and solubility in water of the starches were determined. Microscopy studies and transmittance measurements were performed to determine the degree of pasting of the potato starches. Starch and polysaccharide hydrocolloids were also characterized in terms of molecular weight. Effect of NPH on the properties of potato starch was studied by the pasting characteristics and the rheological measurements. Flow curves with hysteresis loops, apparent viscosity at constant shear rate of 50 and 300 s<sup>-1</sup>, and in-shear structural recovery tests were carried out.

The useful studies attempted to stabilize both normal and waxy potato starch pastes using guar and xanthan gums. Based on the study some blends of potato starch with NPS were selected, which tended to rebuild their structure. The latter had the DSRs (degrees of structure recovery) equal or close to 1.

It was found that the thixotropic properties of potato starch pastes, depended on the amylose content, the temperature of the preparation and the concentrations of both starch and NPH in the blends.

The pattern of the flow curves revealed that the NPS pastes were either thixotropic, antithixotropic or mixed thixotropic/antithixotropic.

In turn, waxy potato starch (WPS) had antithixotropic or mixed thixotropic/antithixotropic properties. NPS pastes of low concentration (2 %) prepared at 80°C had thixotropic properties. Mixed thixotropic/antithixotropic properties had 2 % pastes

prepared at 95, 121 ° C and 3 %, prepared at 80, 95 and 121 ° C. The antithixotropy in 4 and 5 % NPS pastes was found at all applied temperatures of preparation.

The size of the areas of the hysteresis loops was dependent both on the temperature of pastes preparation and on the concentration of starch in the blends. The highest values of the total area of the hysteresis loops showed the NPS and WPS pastes obtained at 80 and 95 ° C, and the lowest - at 121 ° C, respectively. Rebuilding of the thixotropic structure was more difficult in the pastes received at lower temperatures, due to the entanglement between the polysaccharides chains, aggregation and the presence of the swollen granules. The presence of these granules in the continuous phase resulted in heterogeneity of the mixtures and the resulting flow curves intersected. In contrast, higher preparation temperatures promoted the formation of shorter starch chains of lower ability to entanglement, which reduced the viscosity, thereby enabling more efficient recovery of the structure after shearing.

In the in-shear structural recovery test without and with pre-shearing the 2 and 3 % NPS samples obtained by pasting at 80 ° C, had a DSR less than one, which indicated the thixotropy. In the other studied concentrations (2 – 5 %) and the pasting temperatures (80, 95 and 121 ° C) the DSR values were greater than 1, indicating the creation of a new structure or antithixotropic behavior, at high shear rate. The DSR values of the waxy potato starches at the concentrations and pasting temperatures tested were greater than unity, with the exception of the sample of 2 % pasted at 121 ° C, which had the DSR value lower than unity (0.97). This was however very close to 1, thus the structure after shearing has been almost completely rebuilt.

Stronger antithixotropic character, during shearing at 50 s<sup>-1</sup> showed pastes of WPS, what probably was affected by the content of amylopectin. In comparison to the NPS, these properties were evident even at 121 ° C. A high shearing rate of 300 s<sup>-1</sup> caused the thinning of the samples, and resulted in rapid equilibration, and this effect was most pronounced in the samples prepared at 121 °C.

The addition of NPH to the potato starch pastes significantly changed the rheological properties of resulted blends. An addition of the guar gum to the NPS and WPS pastes increased the area of the hysteresis loops with respect to starch pastes without NPH, while the xanthan gum caused the opposite effect. This behavior was explained by the lower resistance of such systems to shearing forces, due to the thermodynamic incompatibility between the anionic GX and negatively charged phosphate groups of the potato starch. These phenomena can cause also the phase separation and the decrease of the viscosity of the pastes.

Rigid chains of xanthan gum oriented in the direction of shear forces, evoke the better stabilizing effect of the potato starch pastes, than the guar gum chains. The addition of both NHP can be used to obtain rheologically stable starch pastes.