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# Effects of cross-linking and acetylation on oat starch properties

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ABSTRACT

Starch samples separated from oat were modified with two different levels of $POCl_3$ (0.5 and 1.0 g $kg^{-1}$) as a cross-linking agent and two different levels of acetic anhydride (6% and 8% (w/w)) for acetylation. Swelling factor, thermal properties and retrogradation measurements were evaluated to characterise the influence of phosphorylation and acetylation on oat starch. Cross-linking decreased the swelling factor and did not improve gelatinization temperature while it increased synaeresis in comparison with native starch. Acetylation increased swelling factor but reduced gelatinization temperature and synaeresis of oat starch.



## 1. Introduction

The interest in oat has been accompanied by an increased interest in study of its starch. Limited research suggests that oat starch does possess some unique chemical, physical, and structural properties (Sowa & White, 1992). Starch plays an important role in textures of many kinds of food products and serves as a major source of energy for humans. In some cases, however, native starch does not meet the functional properties required in food products such as thickening and stabilization. Therefore, starch used in the food industry is often modified to overcome undesirable changes in product texture and appearance caused by retrogradation or breakdown of starch during processing and storage (Van Hung & Morita, 2005).

Cross-linking reinforces the hydrogen bonds in the granule with chemical bonds that act as a bridge between the starch molecules (Jyothi, Moorthy, & Rajasekharan, 2006). Important factors in the cross-linking reaction include chemical composition of reagent, reagent concentration, pH, reaction time and temperature. Because the degree of cross-linking for food starch is very low, the extent of reaction and yield of cross-linked starch are difficult to measure chemically; hence there is a need for physical property measurement. When phosphorus oxy chloride (phosphoryl chloride, $POCl_3$, MW153.3) is added to starch slurry under alkaline conditions (pH 8–12), the hydrophilic phosphorus group immediately reacts with the starch hydroxyls, forming a distarch phosphate (Hirsch & Kokini, 2002).

Cross-linking alters, not only the physical properties, but also the thermal transition characteristics of starch, although the effect of cross-linking depends on the botanical source of the starch and the cross-linking agent. Decrease in retrogradation rate and increase in gelatinization temperature have been observed with cross-linked starch, and these phenomena are related to the reduced mobility of amorphous chains in the starch granule as a result of intermolecular bridges (Singh, Kaur, & McCarthy, 2007). However, Jyothi et al. (2006) showed that cross-linked starch has more pronounced synaeresis than has native starch because of ordered structure in the starch paste, thus resulting in a higher degree of retrogradation.

Acetylation of starch is an important substitution method that has been applied to starch that imparts the thickening needed in food application. Acetylated starch is a granular starch ester with the $CH_3CO$ group introduced at low temperature. Acetylated starch has improved properties over its native form and has been used for its stability and resistance to retrogradation (Singh, Chawla, & Singh, 2004). It increases viscosity, solubility, swelling factor, hardness, cohesiveness, adhesiveness and translucency of the gels while it decreases initial gelatinization temperature (González & Perez, 2002).

Currently, there is little information on the properties of chemically modified oat starch that can be used to develop further applications. Hence, the objective of this study was to examine the influence of two levels of $POCl_3$ and acetic anhydride on physicochemical and thermal properties of oat starch.

## 2. Materials and methods

### 2.1. Material

Oats were grown in the Lavark experimental field of Isfahan University of Technology. The seeds were dehulled and then ground in a disk mill.

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