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STARCH HYDROLYSIS BY AMYLASE: A CLOSE LOOK AT THE FIRST-ORDER REACTION RATE CONSTANT

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The enzymatic hydrolysis of starch, called amylolysis, converts starch into soluble glucans and glucose through the catalytic action of amyolytic enzyme (amylase and amyloglucosidase). It is central in biological processes (human/animal digestion, grain germination) and in industrial processes (malting, bioethanol production). Determining the rate and the extent of the amylolysis has always been an important topic for the research area, especially for its expected role in human nutrition. The typical in-vitro starch digestion assay involves a digestive α -amylase e.g. porcine pancreatic α -amylase. The amylolysis is a heterogeneous reaction, that takes place at the interface between the solid phase (starch) and the liquid phase that conveys the enzyme. Amongst the various models that can describe the amylolysis kinetics, the most popular is the pseudo-first order reaction model usually cast in its integrated form: $X_t = X_\infty(1 - e^{-kt})$. Where t is hydrolysis time, X_t is the instantaneous hydrolysis extent, X_∞ is $X_{t=\infty}$, k is the reaction rate coefficient. The successful fitting of this equation to amylolysis measurements would imply that the reaction rate is proportional to the amount of digestible starch following the coefficient k . k is generally assumed constant in publications, however in practice a time-dependent coefficient can give better fitting results [1]. The determinants for this time-dependency are still ill-known.

This work presents a rigorous characterisation of the time dependency of the reaction rate coefficient for various starch substrates. To this end, we have compiled and analysed the hydrolysis kinetics of two hundred wheat starches and several starchy materials obtained with extrusion, retrogradation and cryo-grinding to produce samples with controlled properties. Our results revealed that the reaction rate coefficient time-dependency can be approximated in a first approach by a simple model (Fig.1). The parameters of this empirical model are clearly affected by substrate characteristics such as the average particle size, the amylose/amylopectin ratio and the crystalline order. It is worth mentioning that the pseudo first-order model is a special case of this generic model. This result can be used to improve the kinetics analysis of in-vitro starch digestion.

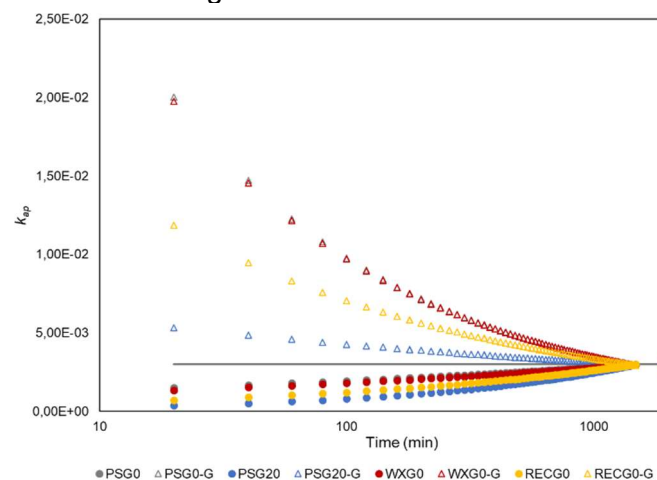


Figure 1 : simple model of the reaction rate coefficient (k_{ap}) over time for different extruded starch samples

[1] Kansou, K., Buléon, A., Gérard, C., & Rolland-Sabaté, A. *Carbohydrate Polymers*, 123, 266–274, 2015.